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Waste Clearinghouses and Exchanges: New Ways for Identifying and Transferring Reusable Industrial Process Wastes

Arthur D. Little, Inc., Cambridge, Mass

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WASTE CLEARINGHOUSES AND EXCHANGES:

NEW WAYS FOR IDENTIFYING AND TRANSFERRING REUSABLE INDUSTRIAL PROCESS WASTES

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This report examines the experience of the industrial waste information clearinghouses operating since 1972 in ten European countries, explores opportunities for the waste transfer concept in the United States, outlines the requirements for successful transfer organizations, and describes their techniques and procedures. The transfer approach seeks to broaden the potential markets for both new and apparently-marginal industrial process residues, and thus to reduce the quantity of potentially-harmful wastes requiring disposal into the environment. The study analyzes concepts and requirements for transferring wastes, distinguishing between "trash waste," having no reuse value whatever, and "scrap waste," having some reuse value. It identifies and estimates quantities of industrial process wastes suitable for transfer, especially in the Philadelphia SMSA. It describes the two basic types of transfer organization--clearinghouses, which transfer only information about wastes, and exchanges, which transfer (and process, if necessary) the actual scrap materials from generator to user; for each type, details are given of services, methods, organization, and finances. Two subtypes of clearinghouses, subsidized and financially self-sufficient, are distinguished. Appendices contain details about existing clearinghouses and exchanges, data and methods for identifying scrap wastes and their uses, economics of transferring wastes, various institutional options, and liability and other legal considerations. The summary lists next steps needed to develop clearinghouses.

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CONVERSION TO METRIC UNITS

In this report, some units are expressed in U.S. customary units. Conversion to metric units is easily accomplished by using the following formulae:

Multiply *miles* by 1.6092 to get *kilometers*

Multiply *tons* by 0.9072 to get *metric tons* (10^3 kg)

Multiply *pounds* by 0.4536 to get *kilograms*

EXECUTIVE SUMMARY

MAJOR FINDINGS AND NEXT STEPS

The U.S. Environmental Protection Agency (EPA) estimated in 1976 that 344 million metric tons (wet basis) of industrial processing residues are generated annually in the United States. EPA suggests* that plant managers and engineers consider the following sequence of steps as they develop their waste management strategies:

(1) *Minimize* the quantity of waste generated by modifying the industrial process involved.

(2) *Concentrate* the waste at the source (using evaporation, precipitation, etc.) to reduce handling and transport costs.

(3) If possible, *transfer* the waste "as is", without reprocessing, to another facility that can use it as a feedstock.

(4) When a transfer "as is" is not possible, *reprocess* the waste for material recovery.

(5) When material recovery is not possible,

  (a) *Incinerate* the waste for energy recovery and for destruction of hazardous components, or,

  (b) If the waste cannot be incinerated, *detoxify and neutralize* it through chemical treatment.

(6) Use carefully controlled *land disposal* only for what remains.

EPA commissioned this one-year study both to explore the feasibility of the waste transfer concept (step 3 and to some extent step 4) and to outline the requirements for a successful waste transfer organization. The purpose of the transfer approach is to help broaden the potential markets for both new and apparently-marginal industrial residues, and thus to reduce the quantity of potentially harmful wastes which require disposal into the natural environment. Hence, established secondary materials markets were not within the scope of the study.

***Federal Register*, Vol. 41, No. 161, pp. 35050-1.

This study began by investigating the several existing European "waste exchanges," whose purpose is to transfer *information* about wastes available and wastes sought as feedstock. It was soon discovered, however, that a few chemical reclamation companies also offer to transfer waste *materials*. This led to the distinction between two types of transfer agents, the "information clearinghouse" and the "materials exchange": the former transfers information only, while the latter accepts residues, analyzes them, identifies new uses, treats them as necessary, and then actively seeks buyers. Both types of organizations were studied.

CONCEPT OF WASTE TRANSFER

Waste transfer is both similar to and different from the purchase and re-use of industrial by-products. In both cases, an industrial process generates, in addition to its principal product, some material which is not usable by the generating company, but which can economically be sold for reuse by another company. When the material has a well recognized value which justifies the costs of recovery, handling, and transportation, it is known as a by-product. When the material has a value which has not been recognized, it is a potentially transferrable waste. So long as disposal is easy and inexpensive, disposal is the waste generator's economically preferred course. Transfer to another plant or industry is economically attractive only when disposal presents major problems, as will increasingly be the case as restrictions tighten and costs rise.

While some transfers occur directly through the initiative of either the waste's generator or its potential user, large-scale realization of the concept requires a third party or "transfer agent." This is because the possible uses are not well established, generators and potential users usually do not know about each other, and companies are reluctant to reveal information about their processes and materials. A transfer agent is therefore needed to identify generators and users to each other while at the same time protecting confidential information until a promising match is identified. Still more transfers can be made if the transfer agent is able to offer additional services, such as assistance with negotiations, consultation about uses and reprocessing requirements, or actual handling of the materials.

The term "waste" has two meanings which are related but distinct. First, it can refer to damaged, defective, or residual material resulting from an industrial process, retaining some or much of its original value; this is "scrap waste" or "scrap". Second, in everyday usage "waste" can refer to any kind of refuse, with no value, which can only be thrown away; this is "trash waste" or "trash". In common usage of "waste", confusion often arises because the distinctions between "scrap" and "trash" are not obvious to everyone. What is considered trash by one person is considered useful by another. This difference between two values seen in one waste is central to both the economic and the technical viability of waste transfer, and creates opportunities for transfer agents.

THE TRANSFER AGENT'S FUNCTIONS

Engineers routinely examine their residues to seek further uses as by-products. In recent years, stricter waste disposal regulations and the scarcity and rising prices of raw materials have made it more economically attractive for companies to research further uses for the valuable components of their wastes. Large companies with many processes and skilled chemical engineers are likely to find those recycling opportunities which exist, particularly within their own manufacturing facilities.

However, even engineers in large national companies are not likely to recognize all waste transfer opportunities outside of their own industry. Moreover, technical discoveries of new ways to find value in scrap do not occur in all companies at once. Also, medium-sized or small companies typically lack the time and skills to find reuses for their wastes.

Therefore, needs exist which a formal, institutional transfer agent can satisfy. Indeed, the difficulties which many engineers face in distinguishing between scrap wastes and trash wastes offer the opportunities for waste transfer agents to provide useful technical and economic services. The transfer agent works at the fuzzy and shifting boundary between wastes and by-products. If successful, the transfer agent will gradually identify what can be described as a "scrap chemicals market," a small but distinct market sector containing materials which are more valuable than trash but less valuable than established by-products. The transfer agent may also lift some scrap wastes with uncertain value up into the category of by-products with well recognized value.

The function of the transfer agent, therefore, is to identify and help bring together the generator, who views the waste as trash without further value, and the user, who views it as scrap with re-use value. In this process, the transfer agent identifies scrap materials of interest to both generators and users.

To be economically and technically useful, a transfer service must recognize the realistic limits of its business or functions. On the one hand, it cannot afford to accept trash wastes. On the other, it would serve no unique environmental or public purpose by trying to deal in regular flows of process by-products with recognized value which are commercially established; and the organization would not be a waste transfer service, but instead one of many competing industrial or chemical brokerages. A transfer agent can thus offer useful activities in only a narrow sector of the chemical materials market—the scrap sector.

REQUIREMENTS FOR A TRANSFER

Transfers of scrap can occur only after many conditions have been established for both generator and user. Each, depending upon his own business and perspective of what is important, must consider the following:

- *Technical feasibility*—the matching between the chemical and physical properties of available waste streams and the specifications of raw materials they might replace.

- *Economic feasibility*—balancing of disposal costs foregone and raw materials costs saved against the administrative and transport costs of implementing a waste transfer.

- *Institutional and marketing feasibility*—values at risk, guarantees of supply, guarantees of anonymity, and mutual confidence among generator, user, and transfer agent.

- *Legal and regulatory*—potential transfer must be handled confidentially, be allowed by law, and be unlikely to lead to liability suits.

POTENTIAL OPPORTUNITIES FOR WASTE TRANSFER

Accurate information about wastes being produced by industrial processes is difficult and expensive to obtain. The first national estimate was compiled by EPA for Congress in 1973. More detailed national estimates by industry were developed in 1974-1976 by a series of 14 EPA-commissioned studies, of which 11 were reviewed for this report.[8-18]

The quantity of manufacturing processing wastes generated in those industries amounts to about 206 million metric tons/year on a wet weight basis. Those wastes having potential value for transfer and reuse total about three percent, or about six million metric tons/year (wet basis). In selected industries, however, the percentage can be much higher: up to 95 percent in pharmaceuticals (SIC 2831), at least 25 percent in organic chemicals (SIC 286), at least 10 percent in petroleum refining (SIC 2911), about 40 percent in paints and allied products (SIC 285), and as much as 20 percent in small industrial machinery (SIC 355).

Wastes generally recognized as having components of potential value include:

- wastes having high concentrations of recoverable metals
- solvents
- alkalis
- concentrated acids
- catalysts
- oils
- combustibles (for fuel)

Available data cover only about one-third of the manufacturing industries which might participate in waste transfers. But they suggest that significant fractions of wastes from other industries may have value which is not now being extracted. The easiest method for testing the hypothesis would be an inexpensive transfer service for an industrial region having many chemical plants, one or more petroleum refineries, and a mixture of other industrial plants.

All industries which manufacture chemicals or use chemicals as raw materials are potential clients of transfer agents. Potential participants in and beneficiaries of waste transfer are concentrated in five industry groups:

- Pharmaceutical (SIC 2831 and 2833)
- Paints and allied products (SIC 285)
- Organic chemicals (SIC 2865 and 2869)
- Petroleum refining (SIC 2911)
- Small industry machinery (SIC 355)

Their wastes with the highest reuse and transfer potential include solvents, still bottoms, and spent catalysts. In general, transfer will take place:

- from larger companies using continuous processes to smaller companies using batch processes;
- from basic chemical manufacturers to formulators; and,
- from industries with high purity requirements (e.g. pharmaceutical) to those with lower purity requirements (e.g. paints).

In addition, almost any industry which needs fuels or cleaning solvents, for example, machine shops and boat builders, is a potential user of scrap wastes. Moreover, reclaimers would naturally become clients of a transfer organization in order to expand their business.

Most potential clients will demand reasonably large amounts of regularly-produced scrap wastes. There is some potential for transfer of smaller amounts of wastes produced occasionally, such as spilled or ruined batches of paint or other chemicals. While many such wastes can be anticipated, their total tonnage, and hence their economic and environmental impact on the area, is not likely to be large.

The economic gains from each potential transfer depend upon the waste generator's savings on disposal costs and the user's savings on raw materials costs. The total gain must cover such transfer costs as transportation, administration, and possibly reprocessing. Generally, scrap wastes valued at less than one cent per pound cannot be transferred economically over a distance greater than 50 miles.

A transfer organization which serves several industries has a greater chance of identifying new transfer opportunities than does one serving only one industry. Thus, while the chemical industry is expected to be the mainstay of any transfer service, participation by customers of the chemical industries should be expected and encouraged. Such customers or major users of chemicals include the textile, paper, wood products, printing, rubber and plastics, leather, ceramics, machinery, and electronics industries.

No government agency, whether federal or state or local, whether a line agency or a special-purpose authority, should try to operate or sponsor a waste transfer service directly. The potential conflicts between their promotional and regulatory roles would render the service unacceptable to its intended industrial clients, and thus largely ineffective. Nonetheless, governments retain an indirect interest because of their public health and environmental protection responsibilities. They can provide significant general support, notably by encouraging waste inventory and market research studies, offering technical assistance to organizers and sponsors of clearinghouses, encouraging generators to keep wastes separated and to analyze their characteristics, controlling disposal and thereby raising its costs, and clarifying the questions and uncertainties which now surround legal liabilities of generators and handlers of hazardous wastes.

DIFFERENT ROLES OF A CLEARINGHOUSE AND AN EXCHANGE

When generators and users cannot satisfy all requirements for a transfer by themselves, they may seek help elsewhere. Their first recourse is to informal networks of colleagues. The second is to professional societies and advertising columns of technical journals.

The third is to an information clearinghouse, which serves the limited function of linking interested trading partners. A clearinghouse transfers only information. It plays only a *passive* role in the transfer process, because it leaves generators and users to negotiate directly.

The fourth recourse is to a dealer, reclaimer, or materials exchange equipped to handle, treat, and certify the characteristics of chemical materials. Such agents play an *active* role, because they stand as intermediaries between generator and user. Of course, many companies reclaim materials with well-recognized reuse value. Only a few small companies in Europe and the United States now seem to be offering, or interested in offering, the full range of services needed to transfer scrap chemicals.

Most existing transfer organizations are operated by the chemical industry associations or governments of European countries as wholly- or partially-subsidized information clearinghouses. Only a few waste transfer agents operate now in the United States; two follow the European pattern, and two take more active roles in identifying matches and negotiating transfers, although they do not physically handle the materials. Several small materials exchanges were identified, one in Europe and the rest in the United States.

Information Clearinghouses

The functions of an information clearinghouse are very limited: to offer a central point for collecting and displaying information, and to introduce interested potential trading partners to each other. They do not actively seek customers, negotiate transfers, set values, process materials, transport materials, or provide legal advice. Any such functions required to transfer a specific material are performed by generators, users, or middlemen dealers.

The basic clearinghouse service is to receive offers of waste materials and requests for scrap materials, list both anonymously, and publish the lists to members and interested nonmembers of their sponsor association. Interested potential traders then contact the clearinghouse, which refers them to each other, but takes no further active role in negotiations which may lead to transfers. Most clearinghouses try to learn whether transfers in fact were completed, but with only limited returns.

All existing information clearinghouses are subsidized by their sponsors. Some charge nominal listing fees. An information clearinghouse requires little capital investment and can be operated at an annual cost of between $10,000 and $90,000 per year, depending on industry response and the degree of active promotion of its service. Financial self-sufficiency could be achieved once the information transfer service has shown its usefulness to industry, by building a large circulation and by setting realistic listing and subscription fees. A participating company could probably recover such fees with one successful transfer a year.

Experience of the older European clearinghouses suggests that about 10 percent of scrap wastes listed will actually be transferred. Approximately one-half of those wastes transferred went to waste brokers and reprocessing companies (i.e., solvent recovery, etc.). The remainder were transferred to manufacturers.

The best sponsor for a clearinghouse is a local or regional industry association, or an organization equally responsive to industry's needs, for three major reasons. First, to be successful, clearinghouses must obtain the support of industry, especially plant managers and engineers faced with waste disposal problems. Second, it is not likely that clearinghouses will be self-supporting until industry learns about the assistance which clearinghouses offer. Finally, they must keep identities and waste generation data confidential.

Although information clearinghouses can assist industry, their importance should not be overemphasized. When clearinghouses began in Europe, they received many listings. The initial influx of wastes included many continuous waste streams. In most cases after the first 12-to-18 months of operation, the number of listings declined. Presumably as plant managers either negotiated transfers or decided that their wastes had no value in the current market, they discontinued their listings.

However, in addition to facilitating transfers of specific wastes, clearinghouses provide two useful general services. First, both their existance and listings of available wastes help to educate industrial engineers about the increased opportunities for transferring and using scrap wastes. Second, their series of lists can gradually build an inventory, incomplete but also inexpensive, of industrial processing wastes.

In the next few years, several more clearinghouses may begin in the United States. Even though subsidized clearinghouses can be operated in areas with a low density of industry, they will facilitate a greater number and higher percentage of transfers in heavily-industrialized areas, such as Houston, Chicago, and Philadelphia, having a large number and variety of industries within relatively small geographic regions.

The scope of the typical clearinghouse in Europe is national, and in two cases international. The likely American pattern will be a network of regional clearinghouses, with arrangements to cooperate in cases in which the value of the scrap waste is great enough to cover costs of transporting it between regions.

Materials Exchanges

The services of exchanges are more complex and expensive than those of clearinghouses. Exchanges buy or accept wastes, analyze their properties, identify potential uses, reprocess them as needed, and sell at a profit. They transfer information only as a courtesy to clients or in the course of paid consulting services. Whereas a clearinghouse needs only a part-time staff and office space, an exchange needs highly-competent technical, managerial, and marketing skills, as well as storage and processing facilities.

Financial success depends upon brokering matches to completion. Because of transportation costs, most transfers can occur within about 50 miles only. Exchanges must, for economic reasons, concentrate on those scrap wastes of most value and most likely to find buyers. A materials exchange requires a capital investment of from $200,000 to $350,000, and annual operating costs are expected to fall in the range of $50,000 to $150,000 per year. Economic analysis indicates that a materials exchange service is not likely to become profitable, unless offered together with a range of other established services to chemical industries, such as handling surplus chemicals.

NEXT STEPS NEEDED TO DEVELOP CLEARINGHOUSES

1. Detailed data are needed from one or more operating clearinghouses in order to guide the creation of clearinghouses elsewhere. Such data should include listing activity, costs, and manpower used, and should not overlook the value of contributed volunteer professional time. These operating data must be collected without impairing the anonymity guaranteed to listers.

2. Although the role of the public sector must be only indirect, it is nonetheless important in providing support services, notably by encouraging studies of operating experience and inventories of available wastes.

3. Emphasis should be given to the needs of potential scrap users. Waste generators quickly recognize the potential usefulness of the information clearinghouse service. Moreover, success of the waste transfer concept depends ultimately upon the demands of users of acceptable scrap wastes. Examples of new recycling technologies and successful new types of transfers should be brought to the attention of potential scrap users through technical journals and professional societies.

4. Information about the waste transfer concept and practice should be disseminated widely, to satisfy the interest which is now so evident. Useful techniques include publications, regional conferences, and technical assistance. Various institutional and legal arrangements for clearinghouses should be examined and perhaps tested.

5. A definitive study of legal liability issues is needed in order to clarify the many questions, and to dispel some of the fears, which now present major barriers to participation in waste transfers by generators and potential users. Topics addressed should include transfer of title to wastes, residual liability, variations in law and practice among states, and developing trends both in legislation and in court decisions.

6. One or more subsidized clearinghouses should be encouraged in order to:

   - demonstrate the effectiveness of the transfer concept,
   - identify the existence of transfer opportunities,
   - generate detailed operating data,
   - educate potential transfer participants in industry, and,
   - identify the potential for financial self-sufficient clearinghouses.

7. A financially self-sufficient clearinghouse should be designed and demonstrated over a period of two-to-three years. Various combinations of related services and various forms of institutional sponsorship should be examined.

8. Materials exchange services should be offered and operated only by the private sector. But the public sector should provide general encouragement through technical and information services.

I. INTRODUCTION

PROBLEM AND THE EPA RESPONSE

The U.S. Environmental Protection Agency (EPA) estimated in 1976 that 344 million metric tons (wet basis) of industrial processing residues are generated annually in the United States. This is almost twice the quantity of municipal wastes and more than thirty times the amount of sewage sludge generated annually.[1] *

As ocean dumping is decreased and water pollution and air pollution controls are tightened, these materials will increasingly be concentrated into solids and sludges for disposal on land. EPA estimates that 25 million tons of hazardous wastes are annually disposed of on land. Furthermore, EPA projects that this quantity will double during the next decade.[2]

Section 212 of the Solid Waste Disposal Act as amended required EPA to investigate the problem of hazardous wastes and study the concept of national disposal sites for storage and disposal of these materials.[3] The EPA did this, but recommended that any action on a national disposal site system be made part of a larger strategy based on improved regulatory controls.[4]

The EPA's report was submitted to the President and the Congress in 1973. It concluded that:

- Current practices of hazardous waste management are inadequate.
- This is because adequate treatment and disposal are expensive and, except in the case of radioactive wastes, are not mandated by law.
- What is lacking is appropriate legislative authority over land disposal of non-radioactive materials. Existing authorities are adequate to protect the air, surface waters, and probably ocean waters from hazardous materials, but not land and groundwaters.
- The technology of hazardous waste management is generally adequate.
- A national disposal site system would be expensive, requiring investments of about $940 million and annual operating costs of about $620 million.

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*References are listed at the end of the report.

11

- The private sector is capable of assuming most or all of the responsibility for hazardous waste management, and a small private-sector hazardous waste management industry has in fact begun to develop.

The strategy recommended in the report is first to establish appropriate regulatory controls, then to monitor the response of the private sector, and only later to take further government action if that is found necessary.[5]

EPA currently proposes the following order of preference and sequence of steps for handling industrial waste streams:[6]

(1) *Minimize* the amount of waste generated, by modifying the industrial process involved.

(2) *Concentrate* the waste (through evaporation, precipitation, etc.) at the source to reduce handling and transport costs.

(3) If possible *transfer* the waste as is to another industry which can use it as a feedstock.

(4) When a transfer "as is" is not possible, *reprocess* the waste for material recovery.

(5) When material recovery is not possible,

  (a) *Incinerate* the waste for energy recovery and for destruction of hazardous materials.

  (b) If the waste cannot be incinerated, *detoxify and neutralize* it through chemical treatment.

(6) Use carefully controlled *land disposal* only for what remains.

The present study is concerned with Step 3 and to some extent Step 4. It explores the feasibility of the concept of "waste exchange" and outlines the requirements for successful waste transfer operations.

The study is intended to further the strategy recommended in the 1973 EPA report by outlining one way in which industry can reduce its waste disposal needs. The study is also responsive to the goals of the National Academy of Science, whose 1966 study of waste management identified recovery and re-use of pollutants as the strategy with highest probable long-term utility in alleviating the nationwide pollution problem.[7]

OBJECTIVES AND FOCUS OF THIS STUDY

This study has two major objectives: (1) to assess the feasibility and potential impact of transferring wastes in the United States, and (2) to provide guidelines for the organization and operation of a waste transfer organization. The conclusions are based on a review of the activities of existing transfer organizations; analysis of the technology, economics, and institutional aspects of waste transfer; and extensive discussion of the concept with industries generating and potentially using wastes.

This report will interest primarily existing and potential operators of waste transfer services. The main questions addressed are:

- How do existing transfer organizations operate, using what procedures, and with what results?
- Where can such an organization operate best?
- Who are the most likely clients? What are their needs? How do they behave?
- How can clients best be identified, contacted, and attracted?
- Will their demand for transfer services grow, or at least remain stable over time?
- What proportion of transferrable wastes are likely to find exact matches–that is, find uses without chemical treatment?
- What skills and resources are required to run a transfer organization successfully?
- What are the economics of transferring wastes?
- What legal problems may arise?
- What competition might a transfer service face?

Other readers of this report will include potential sponsors or subsidizers of transfer organizations, generators of wastes, and potential users of wastes having reuse value.

PART ONE

BASIC CONCEPTS AND DATA

II. TRANSFERRING WASTES: CONCEPTS AND REQUIREMENTS

Like most new subjects, this one is developing its own special vocabulary, in which many terms are used with various and confusing meanings. Among the basic tasks typically needed in a new field, just as important as collecting and analyzing data, is to develop and standardize its terms. When each term used in this report first appears in the text, the rationale for the choice and definition is stated; the meaning is also given in the Glossary.

The term "exchange" is now being applied quite broadly, as in, "After *the exchange* opens, many companies may wish *to exchange* their wastes." It is used to describe organizations ranging from publishers of information lists to reprocessing companies, and it is applied to all types of inter-industry movement of wastes.

Inter-industry transactions rarely take the form of exact swaps, in which Plant A gives its waste to Plant B and receives Plant B's waste in return. Moreover, these transactions are not necessarily made for profit or even for money; in fact, the generator may have to give the waste away or pay the user to accept it. Therefore, it is useful to adopt a term broader and more neutral than "exchange." "Transfer" was chosen, because in common usage it includes any kind of movement from one owner or location to another.

To refer generically to the "exchange" organization, whether its role is that of clearinghouse or of broker, this report uses the terms "transfer agent," "transfer service," or "transfer organization." This report identifies two distinctly different types of transfer organizations, offering distinctly different types of assistance in transferring wastes; the common term "waste exchange" describes only one of these.

THE CONCEPT OF WASTE TRANSFER

The concept of waste transfer is analogous to that of the purchase and re-use of industrial by-products: an industrial process generates a material which is not the principal product and is not usable by the generating company, but which can economically be sold to, and used by, another company. The difference is that a by-product's recognized value generally justifies the costs of recovery, handling, and transportation, while the recognized value of a waste generally does not. So long as disposal is easy and inexpensive, it is the economically preferred course. Transfer to another industry is economically attractive only when disposal presents major problems. This, of course, will be the case increasingly as disposal is subject to tighter restrictions and as its cost rises.

While some transfers of industrial wastes are accomplished directly through the initiative of either the company generating the material or the company seeking it, large-scale realization of the concept requires a third party. This is true mainly because the uses in question are not well established, generators and potential users often do not know about each other, and companies are often reluctant to reveal information about their processes and materials. An intermediary is needed to enable generators and users to find each other while at the same time protecting confidential information until a promising match is identified. Still more transfers can be made if the third party is able to offer additional services, such as assistance with negotiations, consultation about uses and reprocessing requirements, or actual handling of the materials.

A transfer agent does not operate in a vacuum, but instead within a complex economic and technical environment. It is therefore important to understand the structure of the market for chemical materials. In its basic form, the market consists of three layers:

- Primary or Raw Materials
- Processing By-products
- Wastes

The top layer of raw or virgin materials includes the most valuable materials. It includes raw materials from nature, for example sulphur or salt. It also includes virgin manufactured materials, for example plastics, which manufacturers need for their processes and thus view as primary materials.

The middle layer of processing by-products includes materials which are often less pure and less valuable than primary materials. Common examples are solvents from pharmaceutical and paint processing, slag from steel making, and rejected lead plates from lead acid batteries. These examples have recognized value as material inputs for some manufacturers. But their values are set, of course, by supplies of and demands for competing raw materials. When primary materials are plentiful and cheap, processing by-products may have little demand, and thus little value in commerce.

The bottom layer of wastes includes materials generally viewed as having no value whatever. In the eyes of their manufacturers, they should be disposed.

This description of the three-tier market is, of course, a simplified and static summary of many relationships. Closer examination is needed of materials in the bottom category of wastes.

Waste: Scrap or Trash?

The term "waste" requires clarification, because it has two meanings which are related but distinct. First, it can refer to damanged, defective, or residual material resulting from an industrial process; such materials typically retain some or much of their original value. Therefore, this report refers to them as "scrap waste" or "scrap."

Second, in everyday usage the term "waste" can refer to many kinds of refuse; such materials have no value, and can only be thrown away. Therefore, this report refers to them as "trash waste" or "trash."

However, the confusion in common usage of "waste" arises often because the distinctions between "scrap wastes" with some value and "trash wastes" with no value are not immediately obvious. Often, what is considered trash by one person is considered useful by another. For example, the process of manufacturing textiles produces irregular trimmings and scraps of materials which cannot be reprocessed for sale as finished cloth; but they can be used to wipe oil and dirt from machinery. Another common example is the scrap from the metal-working industry, consisting of shavings, scraps of metal, and off-specification parts left over after processing, which find their way to secondary uses—within the same plant, at other plants within the same company, or at other companies via the established scrap metals market.

The distinction between scrap waste and trash waste is important because it is central to both the economic and the technical viability of a waste transfer service. Economically, if a material is truly trash, with no further value whatever, then it will not attract a buyer or even an acceptor; thus, no transfer will result. If an organization accepts such materials, it is not really a transfer agent, but instead a disposal center.

The distinction between scrap and trash therefore modifies the first description of the three-layer market for chemical materials to appear as follows:

- Primary or Raw Materials
- Processing By-products (Recognized Value)
- Wastes
  - Scrap Wastes (Limited or Potential Value)
  - Trash Wastes (No Value)

The discussion thus far has assumed that relations among materials in the materials market are static. But, of course, their value and positions within the market can change. Many process residues in the chemical industry were viewed initially as wastes with no apparent value; then, as uses for which buyers would pay were identified and gained acceptance, they rose to become established by-products with recognized value. Engineers designing new industrial processes routinely examine the residues to seek further uses as by-products. In recent years, both stricter waste disposal regulations and rising prices of raw materials have made it more attractive economically for companies to research further uses for the valuable components of their waste. Large companies with many processes and skilled chemical engineers are likely to find those recycling opportunities which exist, often within their own manufacturing facilities.

However, even engineers in large national companies cannot solve all waste problems. Moreover, technical discoveries of new ways to find value in scrap do not occur in all companies at once. Also, medium-sized or small companies typically lack the time and skills to find reuses for their wastes. Although engineers in different companies do meet at professional societies to compare problems and share solutions, these informal personal networks are by nature limited in scope and uncertain in operation. Therefore, needs exist which a formal transfer agent can satisfy. Indeed, the difficulties which companies face in distinguishing between scrap wastes and trash wastes offer the opportunities for waste transfer agents to provide useful technical and economic services.

The Transfer Agent's Functions

The transfer agent works in the fuzzy and shifting boundary area between wastes and by-products. If successful, the transfer agent will gradually identify what can be described as a "scrap chemicals market," a small but distinct market sector containing materials which are more valuable than trash but less valuable than established by-products. The transfer agent may also move some scrap wastes with uncertain value into the category of by-products with recognized value.

The function of the transfer agent, therefore, is to identify and help bring together the generator, who views the waste as trash without further value, and the user, who views it as scrap with reuse value. In this process, the transfer agent identifies scrap materials of interest to both generators and users.

To be economically and technically useful, a transfer service must recognize the realistic limits of its business or functions. On the one hand, it cannot afford to accept trash wastes. On the other, it would serve no unique environmental or public purpose by trying to deal in regular flows of process by-products with recognized value which are commercially established; and the organization would not be a waste transfer service, but instead one of many competing industrial or chemical brokerages. A transfer agent can thus offer useful services in only a narrow sector of the chemical materials market—the scrap sector.

REQUIREMENTS FOR A TRANSFER

Before describing the transfer system and how it operates within the materials market, it is necessary to recognize the elements of successful transfers. Transfers of scrap wastes, like any other business transaction, can occur only after certain conditions are satisfied for both generator and user. These needs may be divided into four basic groups:

(1) *Technical*—The potential reuse requires that the scrap have specific characteristics.

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(2) *Economic*–Since both parties must gain from the transaction, relations among various costs and prices must be attractive.

(3) *Marketing and Institutional*–Once technical and economic factors are favorable, such matters as knowledge of availability and need, confidentiality, and correct timing become critical.

(4) *Legal and Regulatory*–Potential transfers must be allowed by law, must be handled confidentially, and must be unlikely to result in liability suits.

Although the requirements are many, they cannot be satisfied at random, but rather only in a logical sequence. Table II-1 shows the many requirements grouped into four categories. Although all four categories are necessary, their ranking follows the sequence dictated by the nature of the scrap material and its possible uses. In judging the potential of a scrap material for transfer, there is no point in even considering its economic potential and marketing likelihood before knowing that a technical match is possible.

1. Technical Compatibility

To see value in a scrap waste, a potential user must know that the material will match the input needs of his process. This specifies so many barrels or gallons or tons and certain physical and chemical properties. A major factor determining technical compatibility is purity. The transferability of a scrap waste from one process to another may be hindered by impurities, or even by fear of unknown impurities which may damage the user's process.

The problem of impurities suggests a natural hierarchy which defines the direction that transfers are most likely to take. As shown in Figure II-1, the hierarchy is defined in two ways, by type of industry and by type of material.

Different industries in general have different purity requirements due to the nature of their products and end uses. Grouping industries in order of decreasing purity requirements leads to the following order:

(1) *Producers of fine chemicals*–for example, pharmaceuticals, photographic chemicals, and some organics;

(2) *Producers of chemicals*–bulk organics and most inorganics;

(3) *Formulators*–blenders of paints, cleaning solutions, etc.;

(4) *Hardware manufacturers*–machine parts, boxes, etc.

TABLE II-1

REQUIREMENTS FOR A TRANSFER

SCRAP WASTE WITH POTENTIAL VALUE

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1. **TECHNICAL COMPATIBILITY**
    - Quantity fits user's need?
    - Physical properties right?
    - Chemical characteristics right?
    - Pure enough?
2. **ECONOMIC GAINS**
    - Generator's transfer cost less than disposal costs?
    - User's transfer cost less than raw materials costs?
    - Gains enough to cover transportation costs?
    - Gains enough to cover analysis, treatment, and other transfer costs?
3. **MARKETING FACTORS**
    - Generator knows of user's need and specifications?
    - User knows of scrap's availability and characteristics?
    - Mutual confidence exists between parties?
    - Generator willing to have waste reused?
    - User willing to accept and reuse scrap?
    - Timing right for both parties?
    - Confidentiality of data assured?
4. **LEGAL/REGULATORY FACTORS**
    - Legal liability limited?
    - Transfer not illegal?
    - Data confidential, insulated from government?

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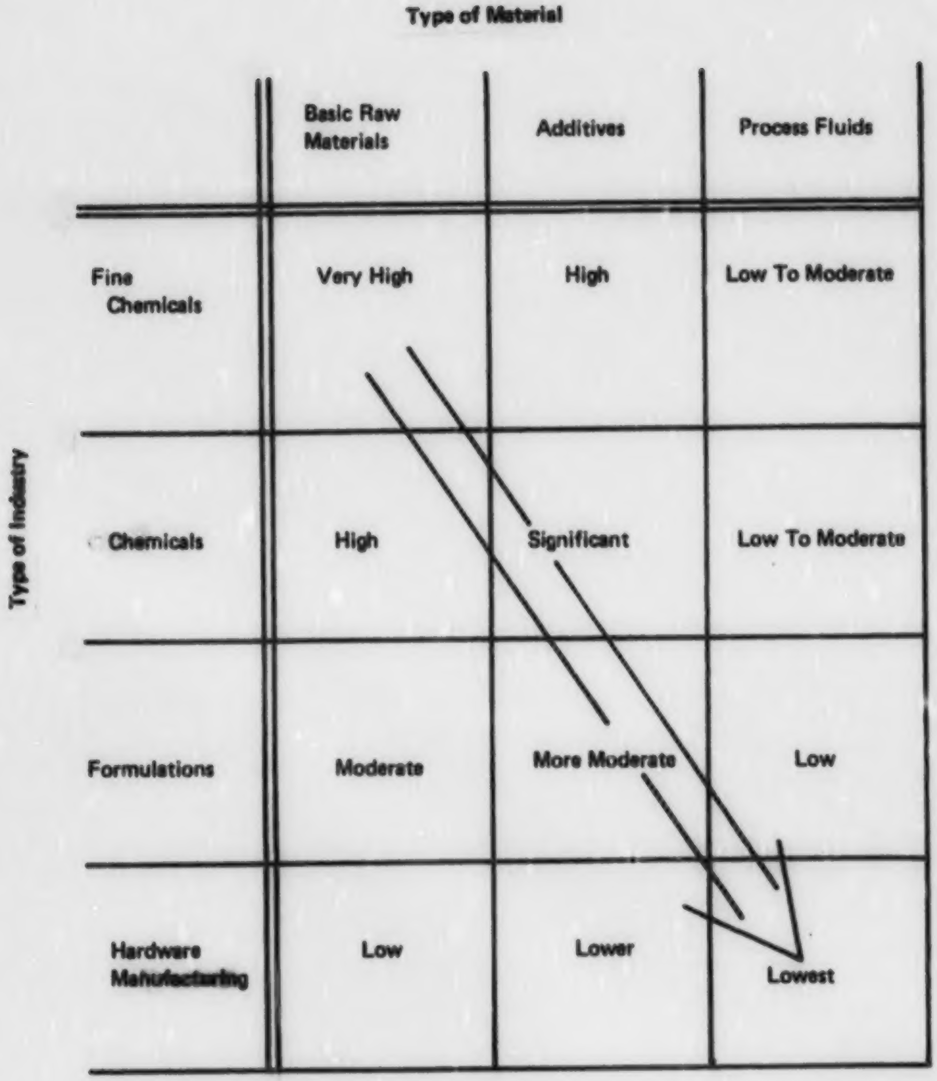
SUCCESSFUL TRANSFER TO USER



Type of Industry	Type of Material: Basic Raw Materials	Additives	Process Fluids
Fine Chemicals	Very High	High	Low To Moderate
Chemicals	High	Significant	Low To Moderate
Formulations	Moderate	More Moderate	Low
Hardware Manufacturing	Low	Lower	Lowest

Source: Arthur D. Little, Inc.

FIGURE II–1 HIERARCHY OF PURITY REQUIREMENTS

First, fine chemicals must be pure; if they are not, manufacturers risk paying significant penalties. Pharmaceuticals are consumed by humans, and thus a particularly high premium is placed on their purity. Photographic chemicals and some organic chemicals used as raw materials for other processes simply do not perform their intended function if impure. Impurities may cause undesirable side reactions which ruin the product (e.g., the photographic print) or poison the catalyst used in a subsequent process. Second, bulk organic chemicals and most inorganics are subject to similar but less strict requirements. Third, formulations, for example paints and cleaning solutions, are generally used in less sensitive applications. Thus, their performance is less likely to be affected by impurities. Fourth, purity requirements for manufactured substances are the least strict. The nature of these products, for example machine parts or boxes, tends to preclude incorporation of the impurity and hence degradation of product function. In summary, moving down the list, there is diminishing need for chemical purity and therefore increasing willingness to use scrap wastes as replacements for raw materials.

Different types of materials are required by each type industry. These can be broadly classified as follows:

(1) *Basic raw materials*—the substances or inputs from which the main products are made;

(2) *Additives*—materials used in small amounts to produce or enhance specific product characteristics; and

(3) *Process fluids*—materials not incorporated into the product but used in its production (for example, cleaning solutions and heat transfer media).

Purity requirements generally also decrease down this list for the simple reason that the products include progressively fewer materials. Therefore, within each industry, wastes are likely to be transferred down the list; for example, the scrap waste from a basic production process may become a process fluid input to another process.

These two lists, when combined in Figure II-1, show that purity requirements are highest for raw materials in the fine chemicals industries. They are lowest for process fluids in the manufacturing industries. Exceptions exist, of course. But this two-dimensional hierarchy is useful in identifying the natural market for a transfer service. If the organization is to be most effective, it must cover a broad range of industries. For example, even though manufacturing industries might not normally participate in transfers of scrap chemicals, they should not be ignored completely. Moreover, within an industry group, the hierarchy of purity requirements helps to focus the search for likely users of a specific scrap waste material.

In the ideal case, technical compatibility between the scrap waste and the user's process is perfect, and the scrap can be transferred "as is". But typically the technical match is less than perfect. In these cases, the scrap waste offered by a generator must be changed to fit the needs of a user. The change may be physical, for example by consolidating several small lots. It may be chemical, for example by reprocessing to remove impurities. Such changes may be made by the user, who knows his own needs best. But they may also be made by the transfer agent, if it has facilities for treatment, or by a reprocessing company.

2. Attractive Economic Gains

The economic requirements for a transfer are obvious. The most fundamental is that the transfer must be advantageous to the user: the net cost of the scrap material must be lower, at the point where he needs it as a resource input, than that of his alternative feedstock. Likewise for the generator, the transfer must be attractive: ideally, the generator wishes to gain by selling it; but more likely he will be content to reduce his disposal costs by giving it away, or by paying a net transfer cost less than his normal costs of disposal.

The critical costs to both generator and user are net. If the transfer requires such costs as transportation and some form of treatment, these may be paid by either generator or user or shared between them. But, unless one or both choose to subsidize the transfer, the net transfer costs they will agree to pay must be lower than their alternative disposal or raw material costs.

3. Marketing Factors

Once technical and economic feasibility seem probable, several marketing factors become important. Generator and user must of course know of each other's need. In the primary and by-product sectors of the market, this linkage function is facilitated by regular brokers.

But in the waste sector, contacts are made much less easily. For example, although the user must know the scrap's technical characteristics, his need is typically difficult to satisfy. Generators usually have no incentive to analyze their wastes, which are often chance mixtures of residues from several processes. Even where an analysis exists, generators are not eager to broadcast such data, because such "chemical footprints" might provide useful clues about new products to competitors.

A factor of great importance is mutual confidence. Generators, especially large companies, hesitate to release scrap wastes to others for fear of possible injury to their reputations for quality; they generally will not release the odd batch of even slightly below-standard product. Similarly, potential users, especially those with high purity needs, hesitate to accept a scrap waste just to save a few dollars where its uncertain impurities might ruin a large production run worth far more money; thus, the user is most interested in the generator's technical reputation, integrity, and willingness to guarantee the scrap's technical characteristics. Mutual confidence is influenced not only by professional reputation, but also by financial strength.

Another factor, more elusive but still significant, concerns attitudes. One influence on potential partners to a transfer is opportunity cost—those activities which could otherwise be pursued profitably if engineers were not worrying about transferring scrap wastes. Because transfers present unusual problems, and thus new risks, those engineers and managers who tackle them must be motivated partly by a philosophy that their efforts may benefit society and the environment even if not measurably their own company. Several engineers cite the prevailing "philosophy of waste" as an important barrier to early success of the concept of transferring wastes.

Yet another factor is accurate timing. Generator and potential user must know of their needs at just the right time, when economic conditions, especially the costs of user's raw materials, are favorable.

The number and variability of these market factors show that generator and user must know about each other's needs in detail. When they do not know each other directly, they need the services of a transfer agent.

4. Legal and Regulatory Factors

A major need for both generator and user is to feel free from legal liability arising from a transfer. This often-expressed fear explains the generators' reluctance to release wastes to other organizations; should a third party suffer injuries possibly caused by such material, both generator and user, especially if they are large companies with known financial strength, might become tempting targets for suit. Generators also worry that transferring wastes may increase their exposure to scrutiny by regulatory authorities.

These legal and regulatory factors differ from most of the technical, economic, and marketing factors in that they are beyond the direct control of generators, users, and transfer agents. But these factors, however indirect, still have influence. Disposal costs to generators are largely a function of how stringently landfills are regulated. Freight rates may be discriminantly higher for other-than-raw materials than for competing primary materials, and thus a burden to the whole recycling industry.

III. POTENTIAL OPPORTUNITIES FOR WASTE TRANSFER

NATIONAL WASTE STREAM DATA

Accurate estimation of the likely market opportunities for transfer agent services requires data about wastes being produced by industrial processes. But such data are difficult and expensive to obtain. The first national estimate was compiled by EPA for Congress in 1973.[4] More detailed national estimates were developed by a series of industry studies from 1974 to 1976 commissioned by EPA.[8-18] Several states are now conducting inventories, but results are not yet available. Detailed data at the level of a Standard Metropolitan Statistical Area (SMSA) or an industrial region, such as northern New Jersey or the Gulf Coast, do not exist; instead, estimates for a locality or SMSA can only be derived from national estimates. These national estimates are summarized in the following paragraphs and tables; details about data collection and forecast methods appear in Appendix E.

Table III-1 summarizes for the United States the total quantity of manufacturing processing wastes generated in a number of industries studied for EPA.[8-18] The total quantity for these industries is about 206 million metric tons/year on a wet basis and 147 million metric tons/year on a dry basis. Table III-2 summarizes the types and quantities of known wastes from the industries listed in Table III-1 which might have potential value. This amounts to about 6 million metric tons/year, or about 3 percent of the total. This is an order-of-magnitude estimate, based on the best available waste stream data. The data, however, were obtained primarily to estimate the magnitude of wastes requiring disposal and the hazards that such wastes might present in landfill. In order to estimate transfer potential accurately, the wastes would have to be characterized in far greater detail, preferably on a plant-by-plant rather than on a national-average basis.

Table III-2 lists those wastes reported in EPA's industry studies and generally recognized as having components of potential value, namely:

- wastes having high concentrations of recoverable metals,
- solvents
- alkalis
- concentrated acids
- catalysts
- oils
- combustibles (for fuel)

Information developed and reported in those studies was based upon typical national practices.

TABLE III-1

MANUFACTURING PROCESS WASTES FROM SELECTED INDUSTRIES, 1975 (U.S. TOTALS)

SIC	Industry	Total Waste Stream (metric tons/yr.) Wet Basis	Total Waste Stream (metric tons/yr.) Dry Basis
3691 3692	Storage Batteries Primary Batteries	10,000	–
281	Inorganic Chemicals	68,000,000	40,000,000
286 2879 2892	Organic Chemicals Pesticides Explosives	7,000,000	2,200,200
3471	Electroplating	5,276,000	909,000
2851	Paints and Allied Products	396,000	370,000
2911	Petroleum Refining	1,300,000	600,000
283	Pharmaceuticals	1,218,000	244,000
33	Primary Metals	117,193,000	100,165,000
226	Textiles Dyeing and Finishing	2,099,000	310,000
30	Rubber and Plastics	3,264,000	2,007,000
3111	Leather Tanning and Finishing	203,000	64,000
355 & 357	Special Machinery	366,000	305,000
367	Electronic Components	97,000	68,000
2992	Waste Oil Re-Refining	57,000	57,000
TOTALS		206,469,000	147,299,200

Source: U.S. Environmental Protection Agency, Hazardous Waste Management Division.

TABLE III-2

POTENTIALLY TRANSFERABLE WASTES FROM SELECTED INDUSTRIES (U.S. TOTAL)

SIC	Waste	Potential Value	Quantity (Metric tons/yr., Wet Basis)	Percentage of Total Waste Stream Listed in Table III-1
3692	Reject cells	Metal recovery (17-70% Zn, Hg, Pb, Cd)	1,200	12
	Wastewater treatment sludge	Metal recovery (40% Cr)	25	<1
286 2879 2892	Chlorinated hydrocarbon liquid heavy ends	Degreasing solvents	247,000	3.5
	Other still bottoms	Fuel	1,600,000	22
3471	Degreaser sludges	Solvent recovery	105,000	2
2851	Spoiled paint or lacquer batches and wash solvents	Solvent recovery, upgrading	174,000	44
2911	Coke fines	Fuel	13,000	1
	FCC catalyst fines	Catalyst recovery	117,000	9
283	Halogenated solvents, other solvents, tars, still bottoms, carbon filter aid	Degreasing solvents; Cleaning or paint solvents; fuel	160,000	95
33	Still pickle liquor	6% H_2SO_4 with metals	3,500,000	3
3111	Sludges and trimmings	Leather composites	12,000	6
355 357	Solvents, metals, oils, acids, and alkalis	Recovery and reclamation	73,000	20
Total			6,000,000	3

Source: Arthur D. Little, Inc., estimates.

However, specific plants may generate wastes with characteristics different from those reported as "typical". Furthermore, the studies were designed to determine the "hazardous" components, rather than the physical and chemical characteristics, of wastes. Stream descriptions were not sufficiently detailed to permit definitive judgments about their potential for waste transfer.

Nonetheless, the data suggest that opportunities for waste transfer exist in many industries. For example, up to 40% of paint industry wastes, 25% of organic chemical waste, 20% of machinery manufacturing waste (on a wet weight basis) might find markets with the aid of effective transfer agencies. Furthermore, available data cover only about one-third of the manufacturing industries which might participate in waste transfer. The results lead to the hypothesis that significant fractions of wastes from other industries may have value, and therefore transfer potential, which is not now being extracted. The easiest mechanism for testing the hypothesis would be an inexpensive transfer service for an industrial region having many chemical plants (SIC 28), one or more petroleum refineries, and a mixture of other industrial plants which use chemicals as raw materials.

The EPA industry studies showed that resource recovery by internal recycling is widely practiced. In the lead-acid battery industry, for example, there is in most plants a high degree of recovery via internal recycling. In other sectors of the battery industry, rejected nickel-cadmium, cadmium-silver oxide, and mercury cells are sent to metal reclaimers; but disassembly of the cells and separation of the metal is difficult. In the electroplating, pharmaceutical, and paint industries, waste solvents are generally recovered, in larger plants by their own on-site facilities and in small plants by outside contractors. The metals industries have continuing programs to explore ways to reclaim metals of value. The organic chemical industry continually seeks ways to increase the percentage of raw materials in saleable products, and thus to decrease the proportion of waste; it recovers solvents when economically feasible. The petroleum refining industry sells a large fraction of its coke fines as fuel, and sends much of its spent catalyst out for reprocessing. On the other hand, our contacts with plant managers suggest that even this generally-established recycling practice has not been adopted by *every* plant within the industry. Hence, it should be possible to expand transfer opportunities.

Most of the well-documented large process wastes from major industries are trash at this time; uses have been sought for years, but with little success; thus, the probability that a transfer agent could identify customers to accept a significant portion of these wastes in the near term is very low. However, relatively small quantities of other wastes have potential as scrap, namely:

- waste solvents,
- alkalies,

- wastes high in metal content,
- concentrated acids, and,
- catalysts.

Many of these wastes are not now reclaimed or reused, and thus are excellent candidates for transfer.

In summary, the exact quantity available of transferable wastes is unknown. But the above analysis of national data for a limited number of industries suggests that it might be at least three percent of the nationwide total of processing wastes now being generated and disposed into the environment.

INDUSTRIES AND WASTES SUITABLE FOR TRANSFER SERVICES

All industries which manufacture chemicals (SIC 28 or 29) or which use chemicals as raw materials (e.g. SIC 22–textiles, 24–wood products, 26–paper, 27–printing, 30–rubber and plastics, 31–leather, 32–ceramics, 33–metals extraction, 34–metals products, 35–machinery, and 36–electronics) are potential clients of transfer agents. Such industries generate chemical wastes with possible material or energy value that might be recovered for use in other parts of the U.S. economy. Such industries also purchase virgin chemicals, and might be willing to substitute scrap chemicals if their existence and availability were known.

The close relationship between the chemical industry and most of the Europen transfer agencies is not accidental. Similarly, transfer agents in the U.S. could not be successful without substantial participation of companies in the chemical industry. Their initial contacts, mailings, and advertising should be concentrated in such chemical manufacturing groups as:

- Pharmaceuticals (SIC 2831 and 2833)
- Paints and allied products (SIC 285)
- Organic and chemicals (SIC 2865 and 2869)
- Petroleum refining (SIC 2911)
- Small industry machinery (SIC 355)

Waste streams from these industries with the highest reuse and transfer potential as scrap include solvents, still bottoms, and spent catalysts.

In general, transfers among these industries and to others that use chemicals in manufacture or waste treatment will take place:

- from larger companies using continuous processes to smaller companies using batch processes;

- from basic chemical manufacturers to formulators; and,
- from industries with high purity requirements (e.g., pharmaceutical) to those with lower purity requirements (e.g. paints).

In addition, almost any industry with a need for fuels or cleaning solvents, (for example machine shops and boat builders) is a potential user of scrap wastes. Reclaimers would naturally become clients of a transfer organization, as a means for scanning the marketplace and for expanding their businesses.

Most potential clients will demand reasonably large amounts of regularly-produced scrap wastes. There is also some potential for transfer of smaller amounts of wastes produced occasionally, such as spilled or ruined batches of paint or other chemicals. While a significant number of wastes of this type can be anticipated, their total tonnage, and hence their economic and environmental impact on the area, is not likely to be large.

Transfers may occur within an industry or between different industries. Is the impact of a transfer organization likely to differ between these types of transfer? Transfers within an industry are favored by common knowledge concerning technology, products and raw material requirements and by the likelihood that potential transfer partners already know each other. However, plants within an industry are more likely to have common wastes and common raw material requirements; thus, if a waste cannot be used in-house, it is not likely to be useful to another plant in the same industry.

Plants in different industries may not know each other or be aware of each other's raw material requirements and waste streams. The diversity between plants opens ground for potential transfers, if the parties can be brought together or made knowledgeable about each other.

It seems therefore that a transfer organization which cuts across industry lines has the greater chance of opening up new transfer opportunities than does one acting only within one industry. Thus, while the chemical industry is expected to be the mainstay of any transfer service, participation by those who now purchase raw materials from the chemical industry should be expected and encouraged.

The largest volumes of scrap wastes are in sludges (often waste-water treatment sludges) from a variety of industries, and slags from the ferrous metals industries. But transfer of these materials is not practicable because of their volume, diverse contents and intractable physical form. It is conceivable that some of the constituents of these sludges, notably the heavy metals, could be reused if they could be kept out of the sludge. This can be accomplished only if the waste streams in individual plants could be segregated near their point of origin and dealt with separately.

A SAMPLE AREA: PHILADELPHIA

In order to examine potential opportunities for waste transfer in more detail than is possible using national estimates, particular attention was given to one Standard Metropolitan Statistical Area. SMSAs are designated by the U.S. Bureau of the Census to standardize urban areas for purposes of consistency and comparisons; an SMSA's boundaries are drawn to include both a core city and its natural economic suburbs and hinterlands. A number of areas with heavy concentrations of industries producing process wastes, including the Gulf Coast, the Great Lakes, St. Louis, and San Francisco Bay, offer potential for transfer services.

The Philadelphia SMSA was chosen for this study for several reasons. The major one was that its industrial economy is both large and highly diversified, containing representatives of 98% of all Standard Industrial Code (SIC) categories. It is also near other SMSAs with large industrial concentrations, especially in chemicals. It is a bi-state area, and both Pennsylvania and New Jersey have made notable efforts in recent years to regulate disposal of industrial wastes. Philadelphia offers a variety of institutional forms.

Philadelphia's waste transfer potential was estimated in two ways. First, the volume of scrap wastes was derived from the national industry studies and other data. Second, interviews with 53 plant managers produced data about their needs to offer and to obtain scrap wastes, and about their willingness to consider using a transfer service. Detailed methods and results are reported in Appendix C.

Potential Estimated from Available Data

The types and quantities of Philadelphia SMSA wastes as derived from national data are shown in Table III-3. The scaling factor used for each industry was its employees in Philadelphia as a percentage of its employees nationally in 1975. For example, the pharmaceutical industry (SIC 2831 and 2833) had 18,500 employees nationally, and 312 in Philadelphia, or 1.7%; thus, the tonnage of transferable pharmaceutical wastes produced nationally, 160,000 metric tons/year, was reduced by 98.3% to derive the tonnage potentially transferable in Philadelphia, 2700 MT/yr. These data are not highly accurate, of course, due to uncertainties in local employment and the inherent variability in waste generation rates related to numbers of employees. However, these data are the best available, and allow an initial estimate of the magnitude of the market for transfer services.

Table III-3 summarizes the wastes generated, almost 4,000,000 metric tons/year, of which about 6 percent or about 249,000 metric tons/year, are potentially transferable. Included in this 6 percent are solvents of several sorts, which have potential reuse value if

TABLE III-3

WASTES GENERATED AND POTENTIALLY TRANSFERABLE, PHILADELPHIA SMSA

(1) SIC Code	(2) Industry	(3) Types of Waste	(4) Total Tonnage (MT/yr)	(5) Potentially Transferable Wastes		(6) Potentially Transferable Waste in the largest plant	
				(MT/yr)	(% of Col. 4)	(MT/yr)	(% of Col. 5)
285	Paint and allied products	Paint sludges and solvents	4,800	2,100	45	700	30
2865	Cyclic crudes and intermediates	Still bottoms, tars	1,650	1,650	100	600	35
2869	Other organics	Still bottoms, tars	70,700	70,700	100	28,500	40
2833	Pharmaceuticals	Solvents, bottoms, filter-aids, toxoids	2,900	2,700	95	1,620	60
3312	Iron and steel making	Slags, sludges and pickle liquor	3,490,000	163,000	5	17,300	11
332	Iron and steel foundries	slags, sludges	100,600	–	–	–	–
281	Inorganic chemicals	Sludges	109,000	–	–	–	–
3471	Electroplating	Sludges	2,900	60	2	4	7
3691	Storage batteries	Sludges, Pb compounds	4,000	–	–	–	–
2911	Petroleum refineries	Spent lime, sludges, tank and still bottoms	58,000	6,600	10	800	10
355 & 357	Special machinery	Metals, oils, solvents, acids, alkalis	8,800	1,800	20	95	5
3111	Leather tanning	Sludges, trimmings	2,900	170	6	35	20
Total			3,856,050	248,780	6	49,654	20

Source: Arthur D. Little, Inc., estimates, derived from EPA national industry studies.[9-18]

reclaimed, and still and tank bottoms, which could have appreciable fuel value. The remaining 94 percent consists mainly of slags and various sludges.

Table III-3 also shows the uneven distribution of wastes among plants in each industry sector. Column 6 shows the tonnage of potentially transferable waste associated with the largest plant in each sector. The tonnages range from as little as 5 percent of the total in special machinery to as much as 60 percent in pharmaceuticals. Thus, only nine plants generate 20 percent of Philadelphia's potentially transferable wastes.

The question of how many tons would in fact be transferred with the help of a transfer agent is difficult to answer, because of the many requirements for a transfer, which may not all be satisfied in all cases. However, the likelihood of a successful transfer is influenced by the amount of waste offered: if the amount is too large, there may be no user with sufficient demand to want it; if too small, there may be no user near enough, with a matching need, and willing to run the risks of accepting it.

The transferable wastes produced by the five industrial groups—pharmaceutical, paints and allied products, organic chemicals, petroleum refining, and small industrial machinery—are of three types: solvents, still and tank bottoms, and specialized wastes. The transfer potentials for each were estimated as follows.

Solvents. The potential identified above includes 3,800 metric tons of solvents, 1,900 tons coming from 37 paint plants and 1,900 tons coming from 10 pharmaceutical plants.

Solvents coming from each plant will be unique, differing in solvent concentration and impurities from every other plant, as well as from time to time within the plant. For the most part, solvents must be processed (purified and/or concentrated) for re-use, and the economics of processing are scale-dependent. Large volumes cost much less per unit to process than do small volumes. In addition, larger volumes come from larger companies which are more comprehensively staffed with technical people. Both of these factors suggest that the larger volumes of solvents, for which a market can be found, are likely to be processed in-house or brokered to existing solvent recovery specialists. The smaller volumes from the smaller plants, which are unattractive to the existing recovery industry because of the economies of scale, are the most likely candidates for transfer with help from a transfer service.

Thus, about 30 to 50 percent of the solvents generated in the Philadelphia area (or about 1,100 to 1,900 MT/yr.) might be transferred, provided that the necessary processing can be arranged. The problem is complicated by the fact that the solvents would be available only as separate batches, from many plants, and in amounts ranging from six to 100 MT/yr. per plant. Because of the poor economics of processing small volumes, no more than ten percent (or about 150 MT/yr.) of the total potential would be transferred successfully.

Still and Tank Bottoms. About 70,000 MT/yr. of these wastes are potentially available. Their main use would be as fuel. The larger the plant, the more worthwhile would be the technical effort to utilize them. These bottoms might have a value of $20 per ton (assuming a basic fuel value of $1 per million BTU), so that the largest single plant (producing 29,000 MT/yr.) could realize a value of about $600,000 per year. This is sufficient to invite in-house reuse if that reuse is technically and economically feasible. Smaller quantities in smaller plants have potential annual values ranging from $60 to $3,000 or more. But the smallest ones are of too little value to repay the effort needed for successful transfer or reuse.

Thus, economics uncertainties, problems of scale matching, and risk factors all reduce the potential. No more than about 10 percent (or about 7,000 MT/yr.) would be transferred successfully.

Specialized wastes. The best opportunities lie among small amounts of more specialized wastes, such as concentrated acids, caustic, off-spec materials, spent catalysts, high-metal-content scrap, and some salts. No data are available as to how many or how much of these scrap wastes are generated, either nationally or in Philadelphia. But they are probably generated in small amounts of between 5 and 100 MT/yr. per plant. Their total amount seems unlikely to exceed 5 percent of all of Philadelphia's wastes, or about 190,000 MT/yr. Further, it seems unlikely that more than 10 percent of this amount, or 19,000 MT/yr., could be transferred successfully.

Combined estimate. In summary, the total amount of scrap waste transferred with assistance from a transfer service in the Philadelphia SMSA would amount to no more than about 26,000 MT/yr., or less than 1 percent of an estimated total of 3,856,000 MT/yr. generated, as follows:

Waste Type	Amount Generated (MT/yr)	Amount Potentially Transferrable (%)	Amount Potentially Transferrable (MT/yr.)
Solvents	3,800	3-5	150
Still and Tank Bottoms	70,000	10	7,000
Specialized Wastes	190,000	10	19,000
Totals	~264,000	~10	~26,000

The uncertainties in these estimates are sufficiently general to make the estimates of the amounts of specific wastes with transfer potential very difficult. The interpolation of these base data, collected and reported on a national basis, to the Philadelphia SMSA adds further uncertainty. Estimates of what would actually be transferred must average out technical feasibility factors, attitudes of potential generators and receivers, real and perceived risks, and the timing of offerings and bids. Each of these factors could be sampled only lightly in this study's field work; the averaging of effects from these lightly-sampled factors add further uncertainty to numerical estimates.

However, the estimate is a good representation of the order-of-magnitude of the potential. The impact of a transfer service, expressed as a percentage of total industrial process wastes generated in the Philadelphia SMSA, would be small. In particular industries, however, it could be substantial.

Potential Estimated from Field Interviews

Interviews with 53 plant managers produced the following summary conclusions:

- Internal recycling and by-product recovery is practiced widely.
- There is now relatively little waste transfer between plants.
- Many managers would be interested in using scrap materials, but are unfamiliar with potential sources.
- For most, the transfer concept was new; many indicated willingness to try it.
- A large number of waste offers, some probably trash but some with potential value as scrap, would be listed with a transfer service. The number of requests would be few.
- Managers willing to try scrap materials would usually require a guaranteed supply for at least 12 months.
- Some managers consider the potential risks and legal liability problems too great even to consider using scrap.

Thus, it appears that many managers are alert to recycling opportunities and willing to try scrap materials, but lack the means to learn about their availability.

IV. TWO TYPES OF TRANSFER ORGANIZATION

The discussion thus far has referred to the "transfer agent" as if only one organizational pattern exists. But in fact, two distinct types are operating in Europe and the United States. It is important to understand clearly the differences between them, so that expectations about each will be realistic.

The major differences concern, first, what each transfers, and second, the role each plays in the basic transfer system. The European organizations transfer only *information*. These are not "waste exchanges", strictly speaking, because they do not transfer wastes as stock exchanges transfer stocks. Instead, they are "waste information clearinghouses", because they receive and refer only information about wastes. By contrast, some companies actually receive and handle the scrap waste *materials* themselves; these organizations are therefore "waste materials exchanges." Whereas the information clearinghouse performs only a few limited functions, the materials exchange performs many. Both types of service exist to help generator and user satisfy all of their requirements for a transfer.

A comparison of these two types of transfer organizations is presented in Table IV-1, which summarizes many points discussed in the following separate treatments of clearinghouses (Part Two) and exchanges (Part Three). The institutional analysis which produced this comparison is described in Appendix E.

Of the various economic actors influencing a transfer organization, the most significant is its sponsor. Most of the existing information clearinghouses are sponsored by industry trade associations and receive financial subsidies. Some of the materials exchanges are sponsored financially by large and established companies and others, by investors. Whichever the form of its sponsorship, a transfer service needs help both to perform its technical functions and, at least in its beginning stage, to survive economically.

This comparison suggests a natural sequence of transfer organizations. The first step represents the several existing information clearinghouses which are sponsored and subsidized. The second step represents the one clearinghouse which is attempting to operate as a commercially-viable enterprise. But a subsidized clearinghouse might evolve into at least a break-even operation if sufficient and continuing demand were demonstrated. Moreover, either form of clearinghouse could help perform the valuable market research functions of identifying both transferable scrap wastes and the extent of potential demand for the more comprehensive transfer services which a materials exchange could provide. Thus, a clearinghouse could evolve into a third step, a materials exchange, or at least outline its opportunities.

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TABLE IV-1

COMPARISON OF CLEARINGHOUSES AND EXCHANGES

DESCRIPTION	INFORMATION CLEARINGHOUSE	MATERIALS EXCHANGE
Current Examples (described in Appendices A & B)	European and St. Louis Clearinghouses	Wimborne—CPR Zero Waste Systems
	I. SERVICES	
• Services Offered	Information and referral only	Buy chemical residues, identify potential users, reprocess as needed, and sell at profit; information and referral only as courtesy, or as part of paid consulting services.
• Role & Strategy	Passive-no assistance in negotiating final matches.	Active—Business success depends on brokering match to completion.
• Geographic Area	No limit; broader coverage increases utility of lists to clients.	Transport costs limit most transfers to radius of about 50 miles.
• Industries Served	Mainly chemical	May be limited, based on special skills, or extensive, to seek more stable volume of activity.
• Scrap Wastes Accepted	All wastes with conceivable reuse value	Only wastes highly likely to be transferable.
	II. OPERATIONS	
• Volume & Regularity	Begin with moderate and variable level, but may later slow to small and episodic; small, part-time, flexible staff makes variations acceptable.	Begin with limited activity to develop reputation, market, and reprocessing capacities; maintaining constant volume important to use staff and facilities efficiently.
• Advertising	Periodic bulletins to house mailing list; journal ads also possible.	Aggressive personal marketing to supplement brochures and word-of-mouth needed to spot opportunities and overcome client reluctance.
• Data Bank	Simple card files workable to begin; computerizable punched-card system will allow upgrading to computer later as volume grows.	Same, but more data for each material; broad industrial contacts are essential sources.
• Facilities	Only part-time office space; access to association news bulletin helpful.	Lab for analysis, tanks and equipment for reprocessing, storage yard, own or lease trucks; second-hand gear reduces capital cost.
• Network	Cooperation among clearinghouses, by publishing each other's lists, broadens geographic and industry coverage.	Inter-regional cooperation possible, but limited by competition for most profitable scrap materials.

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TABLE IV-1 (Continued)

DESCRIPTION	INFORMATION CLEARINGHOUSE	MATERIALS EXCHANGE
	III. STAFF	
• Skills and Experience	Only managerial and clerical essential, but but some industry and chemical knowledge desirable.	Chemicals analysis, materials-handling, detailed industry knowledge, technical imagination, marketing entrepreneurship, and business management; access to legal skills.
• Size	*Minimum:* Part-time manager and secretary, with access to technical advisors. *Maximum:* Dependent upon volume and fees.	1-5 full time with business and technical skills; clerical and day labor staff as volume requires.
• Style of Management	Only reactive.	Entrepreneurial, aggressive.
• Initiative to Create Organization	Group, association, with approval of top management.	Mainly individual, by risk-taking entrepreneurs.
	IV. FINANCIAL	
• Pricing Policy	Free, if subsidized; small listing fee acceptable to clients; later, clients may also accept larger subscription fee.	Negotiated for each waste, with likely minimum of $250. "Loss Leader" pricing possible at beginning to establish reputation.
• Income Sources	At first, subsides from sponsor; later, fees from clients.	Capital from investors or parent company; fees from clients.
• Initial Capital Required	None, if office and publication available.	$200,000-$250,000.
• Annual Operating Budget	$10,000-$50,000	$50,000-150,000.
• Risks Acceptable	Little or none; sponsor's interest is in preserving its reputation.	Considerable risks necessary.
	V. LEGAL	
• Organizational Form	Small staff unit of sponsor, or agency funded by sponsor.	Independent, small, specialized company; or subsidiary of a large, multi-service company.
• Sponsorship	Industry association typical and preferred. Government possible only if client confidentiality guaranteed; state or federal environmental agencies more likely than local or special governments.	Private investors or parent company.
• Government regulation of waste disposal	Helpful, but not essential for a subsidized service; the stricter, the better for a self-supporting one.	The stricter, the better, to create and stabilize market demand.
• Liability	Concern for generators, but not clearinghouse.	As owner and treater of material, exchange exposed to suit.
• Laws affecting transfer organizations	Same as those for any information or research service.	Same as those for any chemical hauler, treater, or reclaimer.

PART TWO

INFORMATION CLEARINGHOUSES

V. SERVICES AND METHODS

SERVICES

The basic service provided by an information clearinghouse is simple and limited. Action begins when a generator sends to the clearinghouse its offer of a waste which it thinks may have scrap value. (Similarly, a user may initiate action by sending his request for needed scrap material.) The clearinghouse then publishes generator's offer among others in its next regular list. A user scanning this list may be interested by the generator's waste, because he sees in it scrap material of value for his manufacturing process. Because the offer is identified only by code number, user next contacts clearinghouse to register his interest in learning more. As clearinghouse passes user's name on to generator, it completes its service. It thus satisfies one of the requirements for a transfer–linking two potential trading partners.

From then on, the clearinghouse plays no further role. Generator and user negotiate directly to discover whether the many other requirements for a transfer–for example acceptable purity requirements, price, transportation costs, and mutual confidence–are already satisfied or can be arranged. If so, generator will transfer its waste to user directly.

The clearinghouse generally does not actively try to help satisfy requirements other than introducing potential transfer partners. Thus, the role of the clearinghouse is only passive. It exists to perform only limited functions–to help generators advertise the existence of wastes with possible reuse value, to help users identify such scrap wastes, and to refer potential partners to each other. All other requirements for a transfer must be satisfied by others–sometimes by generators and users themselves, and sometimes by dealers or waste reprocessors.

Geographic Scope

The area which a clearinghouse can serve effectively can be broad. In fact, the broader its coverage of geographic regions (and materials), the better, because this increases the probabilities of readers finding listings of interest. This is why regional and national clearinghouses in Germany, Austria, and Switzerland publish each others' lists, and why the St. Louis service accepts listings from throughout the United States.

However, the economics of transferring wastes dictate that most transfers will occur between plants located within 50 miles of each other. Only in exceptional cases, with scrap waste of high value and small volume, will the economic benefits to generator and user be large enough to pay for transportation costs over longer distances. Moreover, a clearinghouse subsidized by a sponsor with only regional interests may not wish to continue indefinitely publishing listings beyond the region. Therefore, a network of regional clearinghouses, such as exists in Germany, would also be useful in the United States. The heart of each region should be a metropolitan area with a strong industrial economy having the characteristics described in Chapter III. Such an industrial area would be likely to have both enough persons with the skills and interest to design and operate a clearinghouse, and enough industrial plants to benefit from waste transfers facilitated by the clearinghouse.

Industries Served

A clearinghouse could in theory transfer information about many kinds of waste materials from many industries; in fact, the United Kingdom's clearinghouse accepts such listings as scrap wood. But in practice, such ordinary waste materials as wood and textiles can be readily reused or disposed through incineration. The industrial wastes of most concern are produced mainly by the chemical industries; most clearinghouses have been created by the chemical industries, and they serve primarily the chemical industries and major users of chemicals, as identified in Chapter III.

Scrap Wastes Accepted

A clearinghouse can and should accept for listing all wastes with any conceivable reuse value. Materials which can be classified without doubt as trash, without any reuse value, should not be listed, because their inclusion would place a needless burden both on the clearinghouse staff and the readers of its lists. However, the ultimate judgment about the value in a scrap waste lies with its potential users, who know the needs of their own manufacturing processes, rather than with the clearinghouse staff. The purpose of the clearinghouse service is not to judge which wastes are more or less valuable, but merely to help identify their availability to potential users. Thus, the broader the range of wastes listed, the better.

OPERATIONS AND METHODS

Two variations: subsidized and self-supporting clearinghouses

Most existing clearinghouses are in one way or another subsidized by their sponsors and provide their services free or for only nominal fees. But the usefulness of the waste clearinghouse function and the existence of other kinds of for-profit information services for the chemical industries suggests the possibility that waste clearinghouse services may eventually become feasible as small but self-supporting, commercial enterprises.

Both of these two subtypes, subsidized and self-supporting, have the same functions in the waste transfer process—to identify scrap wastes and to link potential partners. But, whereas the subsidized variation may charge little or no fee and merely wait for listings to arrive for publication, the self-supporting variation must charge enough to cover or exceed its costs and must vigorously seek paying subscribers in order to stay in business. Thus, where appropriate in the following comments about operating methods, the differences between the two variations are noted.

Volume and Regularity

Because accurate data about wastes available for transfer are scarce, predicting the number of listings a new clearinghouse may expect is difficult. Several years of experience by some European clearinghouses suggest the pattern of an early surge of activity, perhaps as a backlog of continuous wastes are offered, tapering off to more modest numbers of listings with a large proportion of one-time or episodic offerings.

Such fluctuations do not seem to cause problems for subsidized clearinghouses, which are operated only part-time, as volume requires, and by staff members with other regular duties in the sponsor organizations. For a commercial organization, however, such fluctuations suggest that the clearinghouse service would not be launched with expectations of early profitability; instead, it should be offered first as an adjunct to established information services to the chemical industries, for example as a column in trade journals or a section of a newsletter listing offers and requests for surplus chemicals.

Advertising and Publishing

The main publication channels for subsidized clearinghouses are regular publications of their sponsors, for example monthly bulletins of trade associations or chambers of commerce. In addition, clearinghouses should reach out to potential readers through the pages of journals read by the chemical and chemical-using industries, including both chemical trade journals (such as listed in Appendix C) and environmental journals and newsletters, which are likely to be read by environmental engineers of large companies; this may be done not only by paid ads with tear-out subscription forms but also by free ads, news stories, and letters to the editor. Finally, a clearinghouse may, as its listings and file of interested persons grow, publish its own monthly or bimonthly bulletin, printed and mailed in facilities of its sponsor.

How often the clearinghouse should publish its bulletin is governed by trade-off considerations. European practice varies, from Italy's weekly list to Great Britain's quarterly bulletin, but with most publishing monthly. If a clearinghouse publishes seldom and irregularly, only when enough listings have accumulated, it runs the risk of carrying information which is out-of-date; but if it publishes only short lists too often, it risks carrying many repeat ads and incurring mailing costs beyond its income. Thus, the best course is to have the list published as part of an established monthly bulletin or journal with large circulation. Next best is for the clearinghouse to publish specially for its own gradually-accumulated mailing list, beginning bi-monthly and adjusting the frequency later as it learns the volume and stability of demand.

A self-supporting operation will be unlikely to receive free aid from journals, but should instead use its own established news bulletin while building up a file of subscribers especially interested in information about available and requested wastes. Although extensive direct-mail advertising could be done by both subtypes, this approach requires skill and investment; return rates of only 2 or 3 percent are considered good. A subsidized service should therefore take advantage of normal mailings by its sponsor to advertise and to publish lists. A commercial service, however, is probably already using direct-mail techniques, and so this would be a cost-effective approach to plant managers, environmental directors, and presidents of potential waste generating and using companies. Names of such persons can be bought from regular brokers of direct-mail lists.

Data Collection and Storage

The simplest system is a one-page form (Figure V-1). It both registers each offer or request and keeps data about each on file. Each waste offered or requested is assigned a code to preserve confidentiality. Most clearinghouses use an alpha-numeric code, consisting of a letter to indicate an offer or request, and a number (1, 2, 3, . . .) assigned in the order received; this code number is entered in the lower right corner. The upper right hand corner contains the four-digit SIC number to identify the respondent industry. Company name, address, telephone number, and name of contact are entered in the upper portion. The zip code is highlighted because it provides a good indication of geographical location.

The registration form requests many specifications. Companies may either not know or not wish to reveal some of these data. But the German clearinghouse experience (Appendix A) suggests that many such specifications can be obtained and can increase possibilities for transfers. The prospect of possibly locating a market for wastes that were becoming difficult to dispose of acceptably seems to have stimulated many companies to find out enough about their wastes to be able to list them. The strict confidentiality maintained by the European clearinghouses has also been a major factor contributing to their success in obtaining

WASTE MATERIAL REGISTRATION FORM

A. Confidential Information (for Clearinghouse use only; will not be released without permission):

Name of company/plant: ____________________ Industry SIC Number (4–digit): ____________

Name/number of plant ____________________

Street address ____________________

City & State ____________________

Zip Code ____________

Contact Person's Name: ____________________ Title: ____________

Telephone (with area code): ____________________

B. Publishable Information (to appear in Clearinghouse's next listing; provide only those data which you are able and willing to supply):

Material Is: Offered/Requested (circle one)

Type (select code)* ____________________

Name ____________________

Quantity/Period# ____________________

Continuous/Intermittent# ____________________

Lab Analysis Available? ____________________

Additional data

Specifications:

Physical form ____________________

Chemical composition (list % in descending order) ____________________

____

____

____

Impurities (ppm) ____________________

Surface tension ____________________

Melting point ____________________

Boiling point ____________________

Viscosity ____________________

pH ____________________

Other properties ____________________

____

*Acids – Ac; Alkalis – Al; Inorganics – I; Organics – O; Metals – M; Oils and Waxes – OW; Catalysts – C; Rubber & Plastics – RP; Miscellaneous – Mi.

#List amount per period, e.g. gals/week, tons/month. Describe whether material is offered/requested on a one-time, regular, or irregular basis.

For Clearinghouse Use Only:

Identification Number ____________

General Location ____________

FIGURE V–1 FORM FOR REGISTERING AN OFFER OR REQUEST WITH CLEARINGHOUSE

data. This form, can help to educate plant managers about what they should know about their wastes. Finally, such data would be useful if, after several years of operation, the published listings became the data base for an inventory of available wastes in the clearinghouse's region.

The next levels of complexity are, first, a punched-card storage system and, then, computerization. However, these techniques are probably too costly for the small-scale listing service of a subsidized regional clearinghouse. They might eventually become cost-effective for a self-supporting clearinghouse, which might be able to add these data to existing systems and might use them for developing and marketing other services.

Facilities

A clearinghouse requires only a small amount of office space, standard clerical equipment, and access to reproduction facilities or news bulletins, all on a part-time basis. These are best obtained from its sponsor organization, whether a trade association or an established commercial service.

Network

As noted above, economics will limit distances of most transfers. Thus, clearinghouses are likely to emphasize the needs of their own regions. But a network of cooperative arrangements among clearinghouses should exist to facilities transfers of those low-volume wastes whose high value can justify the cost of transportation over long distances. Subsidized clearinghouses can arrange to publish each other's lists, in whole or in part. Self-supporting ones can arrange to cooperate when specific inter-regional opportunities arise.

VI. ORGANIZATION AND FINANCES

STAFF

Skills and Experience

The limited services offered by existing subsidized clearinghouses require only basic managerial and clerical skills by staff members conducting its daily operations. Some knowledge by the manager of industrial chemistry and of client industries is desirable, but not essential. When questions or problems arise requiring technical guidance, managers in practice draw upon chemical engineers associated with the sponsor organization. These engineers could be regular staff members of the industry association. Better yet, a volunteer advisory committee should be set up both to counsel the manager on technical and policy questions, and to serve as a liaison mechanism with industry; its members should be representative of the range of companies likely to take advantage of clearinghouse services, both generators potentially offering wastes and users potentially accepting them. Whereas a core committee of about six to eight persons would be enough to consider technical questions in detail, a larger panel of perhaps 25 representative advisors would provide broader contacts with industry and be a useful sounding board on broad policy questions.

A self-supporting, commercial venture would not have access to technical guidance by volunteers, but could obtain it from engineers on a consulting basis. Moreover, in addition to managerial and clerical skills, it would need marketing and advertising skills to attract subscribers.

Size

A subsidized operation needs only a part-time manager, devoting perhaps three or four hours per week to handling inquiries and editing the listings for publication, assisted by a part-time, perhaps half-time, secretary. These levels of effort could increase in response to higher volumes of offers and requests.

A self-supporting clearinghouse, likewise, could start with only part-time personnel drawn from the parent company.

Style of Management

Existing clearinghouses require only a routine and reactive style of management, in keeping with their subsidized financial basis. But, like information services in other fields, a clearinghouse service could be offered commercially and marketed aggressively, thus requiring an entrepreneurial style of management. The best approach, of course, would be to add the information service about scrap wastes to information services about raw materials, surplus chemicals, and byproducts for the same clientele. This approach would minimize risks and costs by building upon existing facilities, reputation and knowledge of the market.

Initiative to Start a Clearinghouse

Because confidence of industry is such a major requirement for success, a clearinghouse service, whether subsidized or commercial, must be started with great care for establishing a reputation for integrity among prominent members of its likely clientele. The ideal method, adopted by most existing clearinghouses, is to arrange formal sponsorship by an established, prominent, and broad-based industry association, or by an autonomous government institution with backing from a representative committee of industrialists. For a commercial venture, the corresponding method is to obtain endorsements from industry.

In all cases, public approval for creating the service should come from top levels of potential client companies, preferably from their presidents or general managers of their plants located in the clearinghouse's area. Although contacts with a clearinghouse about specific offers or requests might be handled for large companies by mid-level managers or environmental engineers, they cannot do so easily without clear approval from their superiors. Thus, a clearinghouse service should anticipate this need and act from the beginning to solicit and obtain public approval from prominent companies.

FINANCES

Pricing Policy and Income Sources

A subsidized clearinghouse, depending upon the amount of its financial support, need not charge for its service directly; but members of sponsoring industrial associations do pay for it indirectly through their association membership dues. In addition, a clearinghouse could charge separate fees for registering offers or requests and for subscribing to its bulletins. Price sensitivity of clients can be learned only through experience; initially, only a listing fee, of perhaps $5, might be charged to defray expenses; but, after the service has shown its usefulness, the listing fee might be increased and a subscription fee charged to non-listing readers, following the practice of newspapers and journals publishing classified ads.

If a clearinghouse were to offer its listing service only for a fee, its clients would have to subscribe, even though most listings would not be of interest, in hopes of occasionally identifying a trading partner with an attractive material within an economic distance. Indeed, one successful transfer could save a participating company many times the subscription fee. Thus, a clearinghouse policy of broader coverage should lead to a correspondingly greater volume of listings and a lower schedule of listing and subscription fees, which should make its service too useful and inexpensive for potential clients to ignore.

A chamber of commerce or other private-sector association which sponsors a regional clearinghouse may in time object to subsidizing a nationwide information service which benefits a large number of clients outside of its region and not members of the association; at that time, when the clearinghouse would presumably have proven the continuing demand for its service, it could raise its listing fee and perhaps add a subscription price, both set so as to cover its costs. Thus, policy pricing is related to policy on geographic area served.

The mix of industries using a subsidized clearinghouse or subscribing to a self-supporting service is immaterial, since neither subtype would derive its income directly from the waste transfer transactions between generators and users. However, if participants or subscribers to a service were to derive no benefits from it and anticipate no future benefits, they might not want to continue to receive bulletins. Both subtypes should therefore solicit participation from likely generators of valuable wastes (e.g., the chemical, electroplating, electronics, pharmaceutical, and battery industries) and likely users of waste materials (e.g., boat builders, machine shops, ore processors, waste recovery firms, pesticide and paint formulators, fertilizer manufacturers, etc.).

Capital Needs and Operating Costs

Subsidized Clearinghouse. For this first subtype, capital needs are small. A subsidized clearinghouse may be merely one of many services offered by an industry association, and so small as not to have a separate budget. Its level of effort varies, depending solely upon the volume of offers and requests, because it waits passively for them to arrive by mail rather than seeking actively to sell subscriptions. Cost data for existing subsidized clearinghouses are not available. The minimum pro-rated costs might be:

Labor	
Manager (at 10% time or 4 hours weekly)	$2,000
Secretary (20%)	1,500
Sponsor's Executive Overhead	500
Total	$4,000
Office and Communications	
Rent and Utilities (pro rated)	$ 500
Telephone (@ $30/month)	360
Supplies	1,000
Printing (lists, forms, brochures)	1,000
Postage	1,000
Total	$3,860
Contingency @ 20%	1,500
Total	$ 9,360
	say $10,000

This minimum annual operating budget for a subsidized clearinghouse might vary from region to region. The factors changing the estimates would include wage rate differentials in various labor areas, the volume of activity, the amount of managerial time consumed in persuading clients to provide complete listing data, the frequency of publishing and mailing lists, and whether lists were printed and mailed separately or merely included in the sponsor's regular bulletin. Moreover, hidden subsidies might be provided by technical specialists serving as volunteer advisors. Vigorous demand for the service might push these costs up as high as $50,000. Accurate cost and operating data could be gathered only through experience.

Self-supporting Clearinghouse. For this second subtype, initial capital needs would also be small, assuming that the venture is launched on only a small scale as one of many information services provided by an established company. However, its operating costs would be higher. The advertising and selling efforts to recruit paying subscribers would imply more entrepreneurial talent, more managerial and clerical time, perhaps access to legal counsel, and higher office costs. Again, costs would vary with such factors as market demand and mode of publication. (A large-volume operation could eventually justify shifting to electronic data processing of offers, requests, and subscribers.) Operating costs might run as high as:

Labor	
Manager (full-time)	$20,000
Technical professional (half-time)	10,000
Marketing professional (half-time)	10,000
Secretary (full-time)	7,500
Company's executive and legal overhead	10,000
Total	$57,500
Office and Communications	
Rent ($500/month)	$ 6,000
Utilities ($30/month)	360
Telephone ($100/month)	1,200
Supplies	1,500
Printing	5,000
Postage	5,000
Total	$19,060
Contingency	10,000
Total	$86,560
	say $90,000

For both subsidized and self-supporting subtypes, accurate cost and operating data could be gathered only through experience. The logical course is to launch at first only a small service, and to collect and analyze its cost data carefully. Therefore, if demand grows, staff and resources can be added to supply it.

ORGANIZATIONAL AND LEGAL CONSIDERATIONS

Organizational Form and Sponsorship

Existing clearinghouses are typically only small services provided among other services by their sponsors. Consequently, they do not appear to be separate staff units, but might become so in time to respond to large and sustained demand.

Various forms of sponsorship for a subsidized clearinghouse are possible (Appendix E). Several state government environmental departments are exploring whether they might begin, or at least encourage, such transfer organizations. Federal and local government agencies might do so, too. A research institute supported by grants and assisted by technical staffs might be an effective sponsor, if it enjoys a good reputation among likely industrial clients of the transfer organization.

The preferred option, however, and also the typical choice of existing clearinghouses, is a broad-based industry association, perhaps a chemical industry trade association or a more broadly representative chamber of commerce. Such associations have the needed staff skills and facilities, and the desire to render services both to their own membership and to their larger communities. Above all, they are the type of sponsor most likely to be acceptable to industry. In contrast, sponsorship by a government agency would be quite unacceptable to most potential users, and might thus limit the clearinghouse's full potential.

For a self-supporting venture, the most logical sponsor would be an established company providing information services to chemical industries. In either case, the region served should be heavily industrialized for best results.

Legal and Liability Questions

Any clearinghouse would be subject to the same legal standards which govern their sponsors and other kinds of research and information services. Since it publishes only information, and has neither the need nor the ability to verify all facts submitted for publication, it occupies the same position as any technical journal. In short, there are no particular legal standards in federal, state, or local legislation which would either hinder or favor a waste information clearinghouse in comparison with any other information service.

Government regulation forcing a clearinghouse to divulge client information would destroy its effectiveness with industry, and thus be self-defeating. A clearinghouse, in effect, contracts only to publish information provided by clients. It could, if it felt the need, include in its registration form and established lists a disclaimer of liability.

PART THREE

MATERIALS EXCHANGES

VII. SERVICES AND METHODS

SERVICES

In contrast to the simple linkage function performed by an information clearinghouse, the services offered by a waste materials exchange are several and complex. As an active dealer in touch with the chemical industries, an exchange identifies potential uses and users, buys or accepts wastes in which it sees value, reprocesses them as necessary (perhaps by chemical treatment, perhaps by consolidating or dividing batches), convinces users of their value, and sells them at a profit.

Whereas the role of the clearinghouse is passive, that of the materials exchange is active. All existing exchanges are profit-seeking firms. They can survive economically only by searching vigorously for transfer opportunities and completing them successfully. Instead of stepping back from the negotiation after introducing generator and user, the materials exchange remains interposed between them. As in stock and commodity exchanges, the two trading partners do not know or deal with each other directly, but only via the middleman or broker. Therefore, the items transferred pass physically, economically, and legally through the hands of the exchange, which earns its income from commissions charged on completed transactions.

It follows from the larger role played by the materials exchange that its organization and economics must be more complex than those of the information clearinghouse. For example, a user must know whether a scrap waste has the chemical and physical properties compatible with his intended use. But a generator typically does not know enough in detail about these properties, often because several wastes from several chemical processes have been mixed; moreover, sufficient analysis can be done only with the potential use in mind. Thus, the materials exchange must operate or contract for laboratory services to analyze the waste. In almost all cases, except for the unusual and ideal case when generator's waste exactly fits user's need "as is", the exchange must process or arrange for processing the material. Moreover, the user wants assurance about the scrap waste's characteristics, sometimes from a legally-binding certificate backed by the exchange's business reputation.

Geographic Scope

Both the characteristics and the economics of these services impose limits on the market area which an exchange can serve effectively. One major factor is cost of transportation: as shown by the economic analysis in Appendix D, this cost limits most transfers to a distance within about 50 miles. Another factor is the frequent and face-to-face contacts which an exchange operator must have with potential clients in order to maintain detailed knowledge of technical trends, to develop the confidence which clients must feel before dealing, and to negotiate the conditions for each specific transfer. Thus, the effective service area is the territory which the materials exchange sales and technical staff can cover efficiently, perhaps a circle with a radius of about 100 miles and including a metropolitan area with a diverse industrial economy.

Industries Served

Which industries an exchange can serve effectively depends upon its business strategy, its reputation, and its technical skills. Some established dealers or reprocessors limit themselves to one industry. But a waste materials exchange is more likely to find the new and unusual opportunities it needs by working among several or many industries. Although its focus is on the chemical industries themselves, an exchange will also find transfer opportunities among other industries which use chemicals but lack the technical knowledge and skills to handle wastes. Another motive for an exchange to diversify across industry lines is to build an aggregate volume or flow of business which is stable, and not dependent on changing economic conditions in one industry.

Scrap Wastes Accepted

Whereas an information clearinghouse can and should accept the broadest possible listing of scrap wastes for publication, an exchange must usually restrict itself to handling only the more valuable materials, which are more likely to bring in reasonable commissions. An exchange deals with passing opportunities and often with only slender margins for profit. It is a business, rather than a subsidized public service. It must therefore take care not to be "nickeled and dimed to death" by accepting many materials in less-than-economical quantities and with low probability of being sold at a profit.

Best Locations

All of the service characteristics described above indicate that the best locations for materials exchanges are areas in which industrial plants are numerous, diverse in nature, and geographically concentrated. Examples are Philadelphia, northern New Jersey, Chicago, St. Louis, Houston, and the San Francisco Bay area.

A secondary criterion for selecting a region is the availability of analytical laboratory facilities, and waste recovery or reprocessing facilities. The exchange may find it useful to contract with such facilities for services that would enhance the prospects for waste transfer.

METHODS FOR ASSESSING AND TRANSFERRING SCRAP WASTES

The techniques needed to satisfy the requirements for a transfer also determine the way in which a materials exchange must organize and operate its services. Most of the techniques described below for a materials exchange are also employed by a waste generator and user when they negotiate a transfer directly, perhaps after being introduced by an information clearinghouse. As the middleman between generator and user, the materials exchange performs or helps to arrange most of the requirements for a transfer. The various methods it may employ for assembling information and assessing the transfer potential of wastes are part of three basic screens corresponding to three groups of requirements: identifying technical feasibility, estimating economic feasibility, and assessing marketing factors.

Identifying Technical Feasibility

Wastes with potential scrap value may be brought to an exchange by waste generators, or may be identified by the exchange's technical staff in the course of other consulting work for industry. Appendix C contains lists of both chemical dictionaries and other sources helpful for identifying potential uses, and of sample wastes and possible uses for each. Once the idea has appeared, the exchange must test its technical feasibility in three respects:

1. Sensitivity of potential uses to the waste's impurities,
2. Compatibility of the waste's physical properties with raw materials specifications for the intended process, and,
3. Match between the quantity of waste available and the quantity required by the potential user.

Methods for testing are discussed below.

1. Sensitivity to Impurities. The composition of a waste stream tends to vary greatly from day to day, week to week, and year to year, even though produced by one process within one plant. Moreover, waste streams are typically contaminated with impurities. For some applications, the exact composition of a waste stream may be inconsequential. For example, a potential user seeking an alkaline waste to neutralize acids for disposal would be interested only in pH. Waste lime, soda ash, sodium hydroxide, and potassium hydroxide, etc. would all serve equally well, if available in suitable quantities at competitive costs. Some caution, however, would be necessary with respect to toxic impurities which, if present, could cause the neutralized stream to be a hazard for disposal.

Before accepting a waste stream, a potential user should ask the exchange agent for a chemical analysis and/or a sample for analysis by his own lab. Potential users unskilled in evaluating the implications of a chemical analysis should employ a consultant to assist with the evaluation. A materials exchange should therefore offer analytical and consulting services to establish the feasibility of matching the waste with the intended application. The exchange lab should identify and quantify all of the following components:

Volatile organics
Acids
Salts
Cyanides
Non-volatile organics
Alkalis
Metallics
Pesticides

Ideally, every component which is potentially a toxic substance, a contaminant to the user, or at concentrations of 1 ppm and above should be identified, both qualitatively and quantitatively. Moreover, the range over which major components might typically vary during a year should be identified, if possible; "major components" are defined as having concentration greater than 1 percent, the threshold of existing analytical methods and machines.

2. Compatibility of Physical Properties. Technical feasibility often depends not only on a waste's chemical composition, but also on its physical properties. Those properties which are important must be determined for each case in view of the possible uses. If a potential user has drawn up detailed specifications for virgin material suppliers, the waste stream must be tested against the same specifications. Otherwise, the materials exchange and/or the potential user should, as a first step, review the following list of properties to determine which, if any, might affect technical feasibility:

- Physical state at ambient temperatures (liquid, emulsion, slurry, sludge, tar, bulk solid, solid powder)
- Layering
- Suspended solids
- Density
- BTU content
- Viscosity
- Flash point
- pH
- Other

The important parameters should be measured. The exchange's staff can then judge whether they lie within, or could easily be brought within, acceptable ranges.

3. **Quantitative Match**. If a potential user can accept only a small fraction of a generator's waste, the generator would be left with a disposal problem. If the generator employs a waste disposal contractor, a small reduction in the quantity of waste for disposal might not result in a proportionate decrease in disposal costs. There is of course the possibility that the exchange could divide and distribute the waste among a number of users so that the generator's disposal problem could be obviated completely.

If a user's demand for a waste exceeds the generator's supply, the user would still have to purchase some virgin material. If the composition of the user's feedstock changes from waste to virgin material and back, and thus requires changes in his processing operations, the transfer may prove technically infeasible. This will depend upon the ease with which the required processing changes can be made. In labor-intensive industries engaged in batch processing, partial replacement of virgin materials with wastes may present no major technical problems. In continuous processing, a reliable constant source of raw materials may be much more critical. An exchange might possibly tap enough sources of a particular waste to ensure that the user's demand could be satisfied completely; however, since wastes from even one plant tend to vary, the "same" wastes generated by two different plants can be expected to differ even more.

Ideally, of course, the quantity of waste available from a generator will exactly match the quantity required by a user. But such cases are expected to be relatively rare.

Estimating Economic Feasibility

The analysis, formulas, and graphs for estimating economic feasibility appear in Appendix D. It shows the importance of transportation costs, the components of transfer costs, and how to estimate whether a transfer opportunity offers potential economic gains for both generator and user. In brief, the proposed transfer must cost the generator less than his disposal costs, and the user less than his raw material costs. Moreover, the economic gain or saving to each must more than offset the perceived risk which the proposed transfer holds for each–for the generator, the risk that mishandling of the waste might cause injury and give rise to a liability suit; for the user, the risk that unknown chemical properties of the waste might contaminate other, more valuable materials in his manufacturing process. Finally, the economic gain resulting from the proposed transfer must cover transportation costs and transfer costs, notably that of treating the waste to meet the user's specifications.

Assessing Marketing Factors

Many new products fail in the marketplace, in spite of their technical merits and competitive prices. Evaluating the transferability of a waste is not too different from evaluating the salability of any new product: the waste must not only be *objectively* capable of serving a particular need at a competitive cost; it must also be subjectively *perceived* by the potential user as something he wants or needs. If a customer chooses a raw material on the basis of cost alone, he should readily accept a waste at a fraction of the cost of a virgin material. But cost is rarely the only factor governing business decisions. Such other factors as the seller's reputation, reliability, and guarantees can significantly influence the decision of a potential buyer. Waste transfer differs from new product sales in that the waste generator's willingness to sell may not be based solely on economics: such factors as guaranteed confidentiality, fears about liability, and concerns about public image can govern both whether a generator decides to offer his waste and to whom he will transfer it.

A transfer agent must respond to the spectrum of needs and attitudes typical of generators and potential users. Some managers deny that their plants generate any chemical wastes; batch processors of inorganic chemicals seem to be particularly adamant. However, such managers may offer information after being shown studies which list wastes typically generated by their industries. Other managers become intrigued by the possibility that their wastes may have reuse value. This attitude seems more characteristic in small plants than large, and among users rather than manufacturers of chemicals; managers of large chemical plants generally know the characteristics of their wastes and try to reduce their magnitude by changes in processes.

Confidentiality is just as important a requirement for materials exchanges as for information clearinghouses. The generator must believe that any conditions he places upon a waste will be observed by the exchange. Similarly, the user must feel confident that the exchange is not deliberately withholding important information about the waste's properties.

Many plant managers willing to consider the use of scrap wastes need assurance that such chemicals will be available in sufficient quantities for at least a year. But few waste generators can guarantee this. Changes in product line, and changes in manufacturing processes are relatively common, and nearly always affect the nature and the quantity of wastes generated. The materials exchange operator might be able to locate alternative sources, but may not be able to guarantee to the potential user that his needs can be met.

VIII. OPERATIONS, ORGANIZATION, AND FINANCES

OPERATIONS

Volume and Regularity

An exchange's volume of business is likely to be low at first, and grow in relation to such factors as its reputation, the amounts of scrap wastes available within its service area, and willingness of generators and potential users to engage in transfers. Because an exchange has more staff and physical facilities than a clearinghouse, it needs a higher volume of profitable business to pay for them. Moreover, like any business, it needs a reasonably constant volume (Appendix D) to employ its staff and facilities efficiently. But this cannot be assured in the volatile waste business. Thus, an exchange is less likely to succeed financially as a single-service venture than as one among several services, notably consulting, reprocessing, and dealing in surplus chemicals, offered by an established firm.

Advertising and Market Development

General information about an exchange's service area can be assembled from industrial directories and technical literature (Appendix C). The exchange must then identify specific companies and plants likely to need its services. The least effective way to explore market potential is by direct mail techniques; a response rate of only 3 percent to mail solicitations is high. Merely dropping a bulletin on someone's desk does not assure he will read it; even if he does, he may not recognize the possible relationship between wastes listed and his own raw material needs. Nonetheless, those who do respond are likely to become serious prospects, and thus merit follow-up visits.

The most effective way to explore and build a market is unquestionably by personal visits, in order to establish confidence as well as to give and receive information about trends, needs, and opportunities. The recommended sequence of contacts is as follows:

- Telephone the manager of the potential donor or seller plant:
  - describe the exchange's services
  - request information about the composition and quantity of wastes which the plant generates
  - ask if recycling opportunities have been explored
  - discuss whether the transfer opportunity identified by the exchange does in fact exist

  - judge the manager's degree of interest
  - draw out his doubts or objections if any, and try to dispel them
  - ask for a visit, if it seems likely to be useful

- Telephone the manager of the potential acceptor or buyer plant:
  - describe the exchange's role and services
  - ask about his raw materials needs and prices currently paid
  - assess his attitude toward using lower-cost, scrap materials
  - judge his degree of interest in the potential opportunity identified by the exchange
  - seek a visit, if it appears useful

- Visit generators and potential users:
  - establish a sales goal and direct discussion toward it throughout the visit
  - know the plant's products and its likely problems and needs
  - anticipate negative attitudes, e.g., "We don't generate any wastes" or "We can't use any wastes." However, most plant managers are intrigued by the waste transfer concept, even if they assume that they would not participate.
  - draw out and dispel obstacles
  - schedule four visits per day to plants in the same zip code area; write visit notes between appointments
  - obtain, if possible, samples of wastes which might be offered, and specifications of scrap wastes which might be bought.

- Assure that potential transfers are technically feasible:
  - analyze the waste samples
  - match analyses against user specifications
  - determine, by analysis or discussion with the manager of the generating plant, how variable the waste properties are likely to be over time
  - discuss these properties in detail with the manager of the potential user plant, to determine whether they are acceptable

Data Storage

A rich data bank about the wastes generated by industries and plants within an exchange's service area is the key to successful transfers. As an exchange's staff assembles data from both literature and plant visits, it must record and store it in ways which will facilitate identification of potential matches. Initially, an exchange can use the simple form recommended (Chapter V) for a clearinghouse. But soon, the amount of data is likely to exceed the capacity of this system.

Therefore, storage on a punched card (Figure VIII-1) offers both more capacity and more flexibility for rapid retrieval of desired information. Suppose one wanted to know, for example, all sources of acid wastes in the Boston, Massachusetts, area (zip code 021 - -). Retrieving such data from cards would be laborious. With a punched-card system, one could easily select, first, the cards listing wastes in the 021- - zip code zone and, then, the subset of these listing acid wastes, or vice versa. With the card illustrated, one can store data on a company's zip and SIC codes, general types of wastes supplied or used, the quantity of each type of waste available or wanted (by range), and whether the quantity is continuous or incidental. Specific company and waste data may be recorded on the card's front and back spaces.

If and when the amount of data becomes large, punched-card storage allows conversion to a computerized storage and retrieval system.

Facilities

An exchange must have, or have access to, facilities for handling, analyzing, processing, and transporting wastes-in-transfer. It may have all of its own laboratory equipment, pumps, storage facilities, trucks, etc.. Or it may restrict itself to the minimum of equipment and borrow or contract for other facilities and services, for example for analyzing samples and processing wastes. Following the policy of buying only second-hand equipment will help to limit the amount of capital invested in facilities.

Network

Cooperation among exchanges serving different areas is possible when a transfer opportunity appears in which the scrap waste has a value high enough and volume low enough to cover the cost of long-distance transportation. However, this possibility is limited by the natural competitiveness of exchanges for the most profitable wastes and opportunities.

STAFF

The active materials exchange operator must convince both generators to allow their wastes to be marketed, and users to accept them. The investment of staff time, and therefore money, required by personal contact is high, and the expectations of profitable return must be commensurately high. The exchange manager and staff must have detailed and

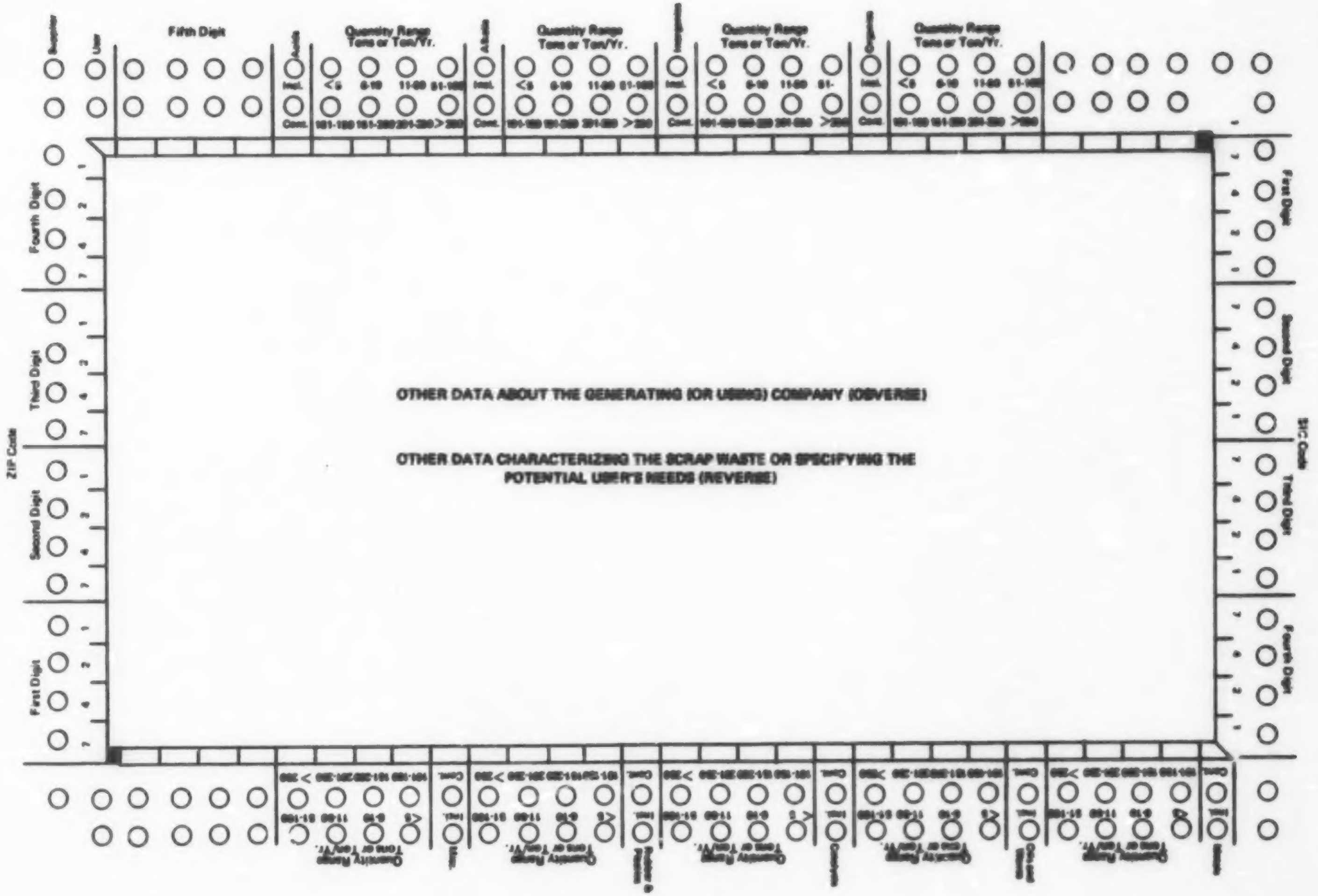

Supplier
User
Fifth Digit
Acids
Alkalis
Organics
Quantity Range Tons or Ton/Yr.
Incl.
Cont.
<5
6-10
11-50
51-100
101-150
151-200
201-250
>250
SIC Code
First Digit
Second Digit
Third Digit
Fourth Digit
ZIP Code
7
4
2
1
OTHER DATA ABOUT THE GENERATING (OR USING) COMPANY (OBVERSE)
OTHER DATA CHARACTERIZING THE SCRAP WASTE OR SPECIFYING THE POTENTIAL USER'S NEEDS (REVERSE)
Metals
Oils and Waxes
Catalysts
Rubber & Plastics
Misc.

FIGURE VIII–1 PUNCHED-CARD FORMAT FOR WASTE MATERIAL DATA FILE

current knowledge of the industries they seek to serve, as well as some knowledge of analytical methods and materials-handling techniques. Imagination is especially important, because the exchange's function is to recognize or create opportunities which previously were not seen or did not exist. Related to technical imagination is entrepreneurship in marketing the exchange's services. When legal questions arise and contracts need to be written, the exchange needs access to legal skills. Finally, to integrate all these skills profitably requires talent in business management. All these skills imply that key members of the exchange staff must have considerable first-hand experience in industrial processing technology.

One or more full-time persons with business and technical skills are needed to run an exchange successfully. They must be supported by a staff of clerical workers, truck drivers, and equipment operators to handle and process waste materials. The size of this staff depends upon volume of activity; existing exchange staffs range from about four to about 45, and are supplemented by outside specialized skills, notably laboratory and legal services, purchased as needed.

FINANCES

The price which an exchange must charge for each transfer depends upon the economics of each case. Appendix D analyzes the several factors. The exchange operator, based on his analysis of the waste's market potential and his transfer costs, negotiates each transaction separately with generators and users. He is likely, however, to set a minimum designed to cover his overhead costs and to discourage dealing in small, uneconomical quantities; this minimum might be about $250.

Some capital investment is needed to rent or buy an exchange's equipment, including storage and treatment facilities, trucks, office space, and a laboratory. The experience of existing materials exchange suggests that the initial capital investment would be between $200,000 and $350,000. The exact requirement would depend upon such factors as the size of the exchange's planned market area, the amount and condition of equipment purchased, the facilities (for example, storage) which might be acquired at low or no cost from a sponsor, and the expected period before reaching financial self-sufficiency.

The annual operating budget would cover such costs as salaries and wages, pensions and benefits, rent or mortgage, utilities, insurance, supplies for office and laboratory and treatment facilities, interest payments, and real estate taxes. Depending upon the exchange's size and services, these are estimated to fall within a range of $50,000 to $150,000.

ORGANIZATIONAL AND LEGAL CONSIDERATIONS

Existing materials exchanges include both small, independent, specialized companies, and subsidiaries of large, multi-service corporations. Financial sponsorship by banks and private investors is possible. But affiliation with and access to the services of a large company with an established reputation in the chemical industries is more likely to assure success. Indeed, economic analysis (Appendix D) suggests that the number of economically-viable transfers which an exchange might complete would be too low to cover the costs of operating the exchange service alone; therefore, the materials exchange service should be only one among several related services for the chemical industries, notably consulting, dealing in surplus chemicals, and reprocessing established by-products.

Legally, an exchange is subject to the same laws and regulations as any business corporation engaged in hauling, treating, and reclaiming chemical and industrial products. As temporary owner of waste materials which might contain ingredients harmful to people or the environment, an exchange would be exposed potentially to liability suits (Appendix F) as one of the normal risks of its business.

APPENDICES

A – INFORMATION CLEARINGHOUSES

B – MATERIALS EXCHANGES

C – DATA AND METHODS

D – ECONOMICS OF TRANSFERRING WASTE MATERIALS

E – INSTITUTIONAL ANALYSIS AND OPTIONS

F – LEGAL ASPECTS OF TRANSFERRING WASTES

APPENDIX A

INFORMATION CLEARINGHOUSES

The majority of existing exchange organizations are operated as wholly or partially subsidized services, on the information clearinghouse model, by the chemical industry associations or governments of European countries. There are only a few waste transfer operations in the United States, and their approaches vary.

EUROPEAN MODELS

Genesis and Organization

In most cases, the impetus for clearinghouses came from national chemical industry associations, loosely equivalent to the Manufacturing Chemists Association (MCA) in the United States (Table A-1). Most clearinghouses are financed wholly by the industry. In Scandinavia, the clearinghouse was formed at the recommendation of an official intergovernmental working group on waste management, and funded for a three-year period, by an intergovernmental foundation, *Nordisk Industrifond*, with matching funds from each country's Federation of Industry. In the United Kindgom, a committee including representatives of several chemical manufacturers recommended establishment of a clearinghouse to the Departments of Environment and of Trade and Industry; the latter is now sponsoring the clearinghouse for a two-year trial.

All clearinghouses appear to have been started on low budgets, with a belief that transfer made sense in principle, but with no certainty about how many transfers would result. Most are sponsored by and integrated with the operations of the chemical industry associations. For example, the Netherlands clearinghouse is administered by one part-time staff person; the Belgium and German each have a part-time director and a full-time administrator; and the Swiss is headed by a lawyer and a chemist, both serving part-time. Costs are kept to a minimum by using existing resources (offices, staff) and existing publications (trade journals, association bulletins).

Government agencies seem to play no direct role except in the United Kingdom and Scandinavia. Although the U.K. clearinghouse is funded by the Department of Industry and operates in a government laboratory, the information it handles is said to be carefully insulated from other government agencies, so as to maintain anonymity. The Nordic clearinghouse is funded by an intergovernmental foundation, *Nordisk Industrifond*, established in 1973 to promote industrial research and development jointly among the Scandinavian countries. The environmental affairs office of each country's Federation of Industry acts as the national clearinghouse, and the central administrative agency is the Swedish Air and Water Pollution Research Laboratory.

TABLE A-1

WASTE INFORMATION CLEARINGHOUSES

	Name of Exchange or Sponsoring		Personal	Accepts Offers/Requests	Distributes	
	Association	Address	Contact(s)	from:	to:	Via
Netherlands (established January 1972)	VNCI (chemical industry association)	The Hague, Netherlands	Mr. Beukers	Chemical industry only	Chemical industry and interested others	Association Journal, *Nederlandse Chemische Industrie*
Belgium (November 1972)	Fechimie (Fédération des Industries Chimiques de Belgique; chemical industry association)	49, Square Marie-Louise, Brussels, Belgium	Mr. Bormans Miss Stuvenhage	All industries (originally chemical industry only)	All interested parties	Association Bulletin, *Chem-Flash*, and subscription publication *Ecochem*
Germany (December 1972)	VCI (Verband der Chemischen Industrie; chemical industry association)	Karlstrasse 21 Frankfurt/Main Germany	Mr. Heinz Keune Mrs. Ilse Müller	Any manufacturing firm	Any manufacturing firm	Bulletin to members and Association Journal, *Chemische Industrie*
Austria (February 1973)	Fachverband der Chemischen Industrie Österreichs (chemical industry association)	Schliessfach Nr. 69 1011 Wien Austria	Dr. Loeschner	Primarily chemical industry	Chemical industry	Monthly Association newsletter
Switzerland (March 1973)	Schweizerische Gesellschaft für Chemische Industrie.	8035 Zurich Switzerland	Dr. Wegmann Dr. Gut	Association members only	Association members only	Monthly Bulletin
Italy (March 1973)	Associazione Nazionale dell Industria Chimica (chemical industry association)	Via Fatebenefratelli, 10 20121 Milano Italy	Dr. Dario Linares	Primarily chemical industry	Association members	Weekly publication of listings
Nordic (November 1973)	Institutet för Vatten och Luftvärdsforskning (headquarters in Sweden)	Box 5607 Stockholm 5 Sweden	H.O. Bouveng H. Hargbäck			
	Federation of Danish Industires	1A Vesterbrogade Copenhagen, Denmark	Mr. Hartig Mr. Christiansen		Federation members free on request; others by subscription	
United Kingdom (November 1974)	United Kingdom Waste Materials Exchange (sponsored by the government's Deptment of Trade and Industry)	P.O. Box 51 Stevenage, Herts. SGI 2DT U.K.	Mr. J. Landville Mr. A. Poll	Manufacturing industries	Mailing list of interested organizations	Quarterly Bulletins
France (November 1975)	Sponsored mainly by the government agencies, Delegation aux Ecomies de Matières Premières, administered at IRCHA (a mixed public-private research organization)	IRCHA 91710 Vert-le-Petit France	Jacques DeLoy, *Nuisances et Environnement*, 40, rue du Colisee 75008 Paris France	All industries	Readers of the publication listed to the right	Classified ads in the technical journals, *Nuisances et Environnement* and *Chimie et Actualite*
United States 1975	1. St Louis Industrial Waste Exchange;	St. Louis Regional Commerce & Growth Assn, 10 Broadway, St. Louis 63102	Roland C. Marquart	Mainly chemical	Individuals & journals	Periodic list
	2. Iowa Industrial Waste Information Exchange	CIRAS, Bldg E Iowa State U. Ames, Iowa 50011		Limited to industries in Iowa		Periodic list

Financial Support and Viability

All clearinghouses have, to date, been subsidized. The U.K. began with a two-year grant of £70,000 (about $38,900). While the costs of the Nordic's headquarters in Sweden were paid by a three-year grant, each country's Federation of Industry contributed an equal amount to operate its national clearinghouse office. The Dutch, Austrian, Swiss, Belgian, German, and Italian clearinghouses are supported by their sponsoring industry associations; their operating budgets were not reported, and indeed Italy responded that its costs are simply included in its association's overhead budget. They charge no fees for their service. These clearinghouses are thus not yet seeking to become financially self-sufficient.

Services and Operations

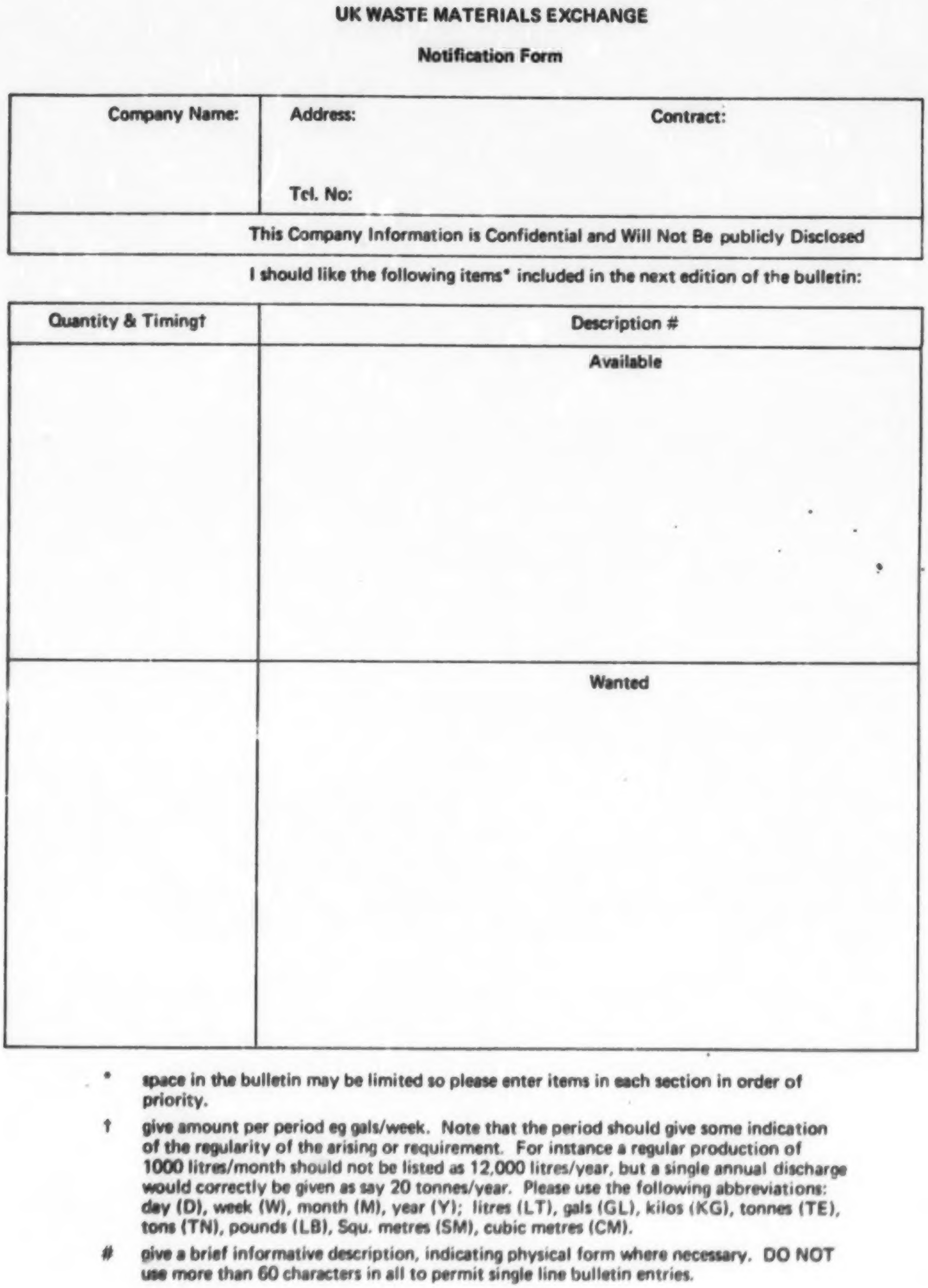
The basic service is simple and inexpensive. A clearinghouse receives offers of and requests for waste materials, using a form such as shown in Figure A-1. The Clearinghouse then codes them to preserve anonymity. It assigns a reference number to each item and indicate whether it is an offer or a request, the type and quantity of material involved, the general geographic location for purposes of estimating transportation costs, and sometimes other information. The U.K. geographic code, for example, is as follows:

A Scotland
B Northern Ireland
C North of England
D West Midlands and Wales
E East Midlands and East Anglia
F Central, Southern, and Southeast England
G West of England

Coded offers and requests are periodically published, sometimes in special bulletins as in the U.K. (Table A-2) and more often in the sponsoring association's regular journal for members as in Germany (Table A-3). The German clearinghouse issues not only its own lists, but also includes those from regional chambers of commerce within Germany and those from the Dutch, Austrian, Swiss, and Nordic clearinghouses.

Readers who see a material of potential interest then write to the clearinghouse, perhaps using forms such as shown in Figure A-2. Such inquiries are forwarded by the clearinghouse to the listers, which may contact potential transfer partners directly to commence negotiations. Clearinghouses usually do not participate in negotiations, but do try later to learn whether or not they led to successful transfers. This basic clearinghouse service is generally free, except sometimes for the publication's subscription fee; the St. Louis clearinghouse, however, charges a $5 listing fee to help defray its expenses.

USE THIS SHEET FOR REPORT TYPING 8-1/2 x 11



UK WASTE MATERIALS EXCHANGE

Notification Form

Company Name:	**Address:** **Contract:** **Tel. No:**
This Company Information is Confidential and Will Not Be publicly Disclosed	

I should like the following items* included in the next edition of the bulletin:

Quantity & Timing†	Description #
	Available
	Wanted

* space in the bulletin may be limited so please enter items in each section in order of priority.

† give amount per period eg gals/week. Note that the period should give some indication of the regularity of the arising or requirement. For instance a regular production of 1000 litres/month should not be listed as 12,000 litres/year, but a single annual discharge would correctly be given as say 20 tonnes/year. Please use the following abbreviations: day (D), week (W), month (M), year (Y); litres (LT), gals (GL), kilos (KG), tonnes (TE), tons (TN), pounds (LB), Squ. metres (SM), cubic metres (CM).

give a brief informative description, indicating physical form where necessary. DO NOT use more than 60 characters in all to permit single line bulletin entries.

FIGURE A–1 U.K. FORM FOR SUBMITTING WASTE OFFERS AND REQUESTS

TABLE A-2

SAMPLE OF ITEMS LISTED BY U.K. CLEARINGHOUSE

SECTION A: MATERIALS AVAILABLE

REF R	QUANTITY		ACIDS & ALKALIS*
AA019C**	35	TN/W	WASTE SODA, CARBONATE 63%, HYDROXIDE 2%
AA023C	50	TE/D	15-20% SULPHURIC ACID WITH METAL SULPHATES
•			
•			
•			
AB051A	1100	KG	POTASSIUM HYDROXIDE FLAKE
....	....	....	.... ***
AB091C	1500	TN/M	30% SULPHURIC ACID, 45% AMMONIUM SULPHATE SOLUTION
AB150F	250	TE/Y	SODA SLAG–TRACES OF ARSENIC, ANTIMONY AND LEAD

REF R	QUANTITY		CATALYSTS
AA021C	1000	LB/W	RANEY NICKEL CATALYST, 5% NICKEL DRY, ALKALI 4%
AA024C	25	TE/Y	SPENT CATALYST, 4-5% VANADIUM PENTOXIDE
•			
•			
•			
AB042D	50	TN	PELLETISED CATALYST, 5% VANADIUM PENTOXIDE IN SILICA BASE

REF R	QUANTITY		INORGANIC CHEMICALS
AA008A	13	TE/Y	55% ZINC CARBONATE CHEMICAL WASTE
AA022C	500	TE/M	20% SODIUM HYPOCHLORITE WITH HYDROXIDE & CHLORIDE
•			
•			
•			
AB054A	75	KG	SODIUM CYANATE
....	....	....	....
AB095F	1	CT	VANADIUM PENTOXIDE
AB096F	2	CT	ZANOX CADMIUM SALTS (CONTAINING CYANIDE)

REF R	QUANTITY		ORGANIC CHEMICALS & SOLVENTS
AA004A	100000	GL/Y	METHANOL/WHITE SPIRIT/ACETONE/WATER, 40:20:20:20
AA010C	200	TN/Y	PETROLEUM CHLORINATED SOLVENTS, APPROX 28% CHLORINE
•			
•			
•			
AB067F	207	KG	SALICYCLIC ACID
....	....	....	....
AB076D	400	GL/M	STARCH SOLUTION
AB078D	3	TE/W	PHENOLIC TAP – 15% FREE PHENOL

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*Other categories not shown in this sample: Food Processing, Metals, Minerals, Miscellaneous, Oils and Waxes, Paper & Board, Rubber & Plastics, Textiles & Leather.

**AA = item available within first 999 listings; AB = item within second 999.

***Dotted line in each category precedes new listings since last *Bulletin*.

Source: United Kingdom Waste Materials Exchange, *Bulletin No. 6*, February 1976, listing 834 offers and 168 requests, for a total of 1,002 of which 83 were new since *Bulletin No. 5*, November 1975.

TABLE A-2 (Continued)

SAMPLE OF ITEMS LISTED BY U.K. CLEARINGHOUSE

SECTION W: MATERIALS WANTED

REF R	QUANTITY	ACIDS & ALKALIS
WA027C	10 TE/D	CAUSTIC SODA SOLID/SOLUTION, LOW IN HEAVY METALS
WA070E	UNSPECIFIED	TANKER LOADS PHOSPHORIC ACID LIQUORS
WA305F	2 TF/W	CAUSTIC SODA SOLID

REF R	QUANTITY	INORGANIC CHEMICALS
WA069F	UNSPECIFIED	TANKER LOADS OF NITROGEN CONTAINING LIQUORS
WA071C	20000 TN/Y	WASTE GYPSUM, HYDRATE/ANHYDRATE, FINE POWDER PREFERRED
WA072C	60000 TN/Y	WASTE SLAKED OR HYDRATED LIME, POWDER OR CAKE
•		
•		
•		
WA791A	30 TE/W	SODIUM SULPHITE/BISULPHITE
WB044E	10 TN/W	RESIDUES CONTAINING PHOSPHATES (NON-TOXIC)
……	……	……
WB104F	10 TN	SODIUM ANTIMONATE (NON-CHEMICAL GRADE)

REF R	QUANTITY	ORGANIC CHEMICALS & SOLVENTS
WA003F	UNSPECIFIED	MIXED SOLVENTS
WA014C	5000 TN/Y	PHENOLIC BY-PRODUCTS
•		
•		
•		
WB033D	UNLIMITED	WASTE METHANOL
WB041G	UNLIMITED	CLEAN OR USED ORGANIC SOLVENTS
……	……	……
WP132C	UNLIMITED	CLEAN OR DIRTY MIBK, MEK

REF R	QUANTITY	FOOD PROCESSING
WA156E	UNLIMITED	BY-PRODUCTS FOOD INDUSTRY, VEGETABLE/ANIMAL, PREFERRED DRY
•		
•		
•		
WB016F	100 TE/N	DOWNGRADED STARCHES

THE INFORMATION LISTED ABOVE IS THAT SUPPLIED BY THE COMPANIES CONCERNED. THE DEPARTMENT OF INDUSTRY DOES NOT ACCEPT ANY RESPONSIBILITY FOR THE ACCURACY OF THE INFORMATION GIVEN AS TO QUANTITY OR QUALITY ETC.

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11/02/76

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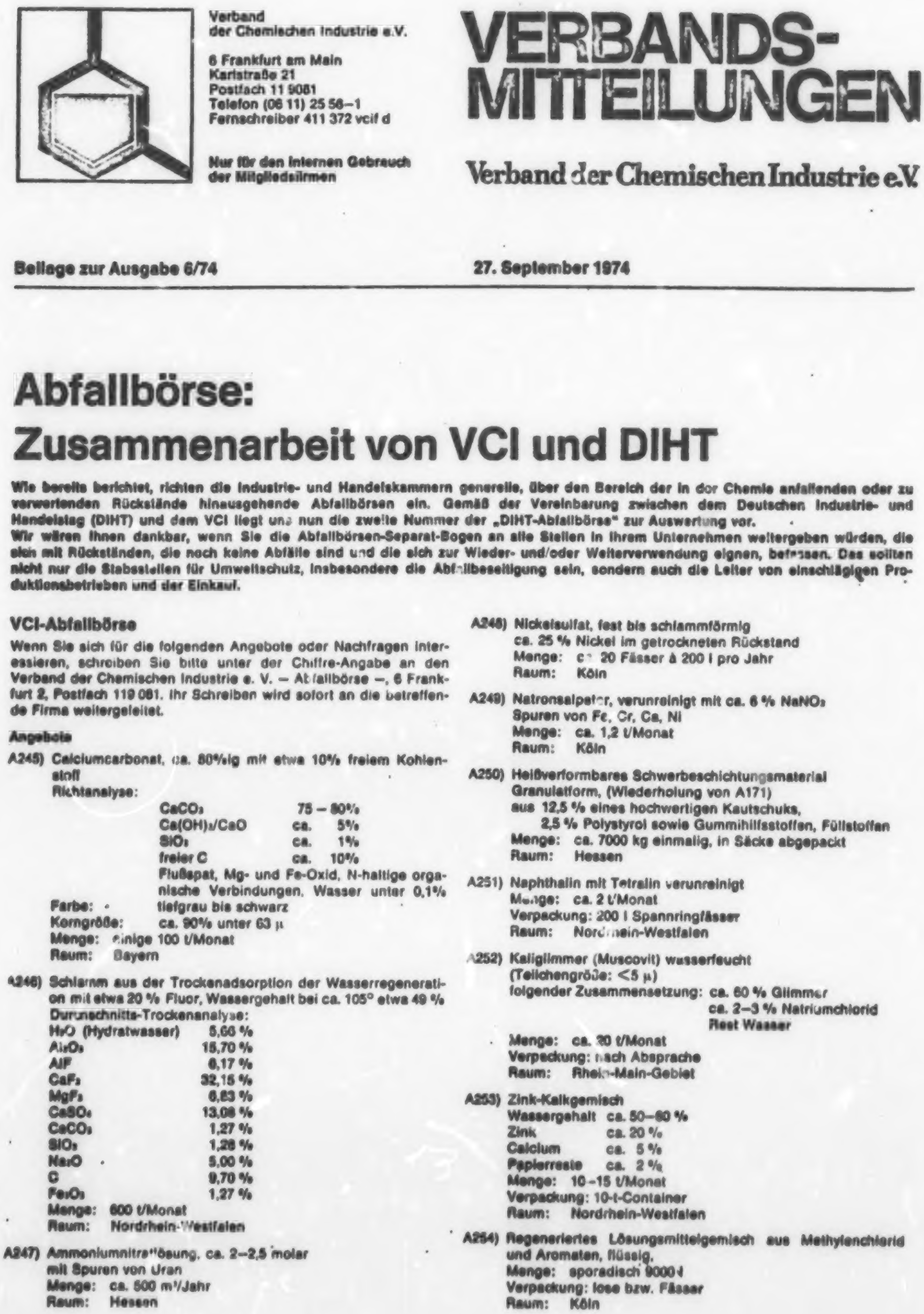
*Other categories not shown are same as in Section A: Materials Available.

**WA = item wanted within first 999 listings; WB = item within second 999.

TABLE A-3

SAMPLE LIST (PARTIAL) FROM GERMAN CLEARINGHOUSE



Verband
der Chemischen Industrie e.V.

6 Frankfurt am Main
Karlstraße 21
Postfach 11 9081
Telefon (06 11) 25 56–1
Fernschreiber 411 372 vcif d

Nur für den internen Gebrauch
der Mitgliedsfirmen

VERBANDS-
MITTEILUNGEN

Verband der Chemischen Industrie e.V.

Beilage zur Ausgabe 6/74 27. September 1974

Abfallbörse: Zusammenarbeit von VCI und DIHT

Wie bereits berichtet, richten die Industrie- und Handelskammern generelle, über den Bereich der in der Chemie anfallenden oder zu verwertenden Rückstände hinausgehende Abfallbörsen ein. Gemäß der Vereinbarung zwischen dem Deutschen Industrie- und Handelstag (DIHT) und dem VCI liegt uns nun die zweite Nummer der „DIHT-Abfallbörse" zur Auswertung vor.
Wir wären Ihnen dankbar, wenn Sie die Abfallbörsen-Separat-Bogen an alle Stellen in Ihrem Unternehmen weitergeben würden, die sich mit Rückständen, die noch keine Abfälle sind und die sich zur Wieder- und/oder Weiterverwendung eignen, befassen. Das sollten nicht nur die Stabsstellen für Umweltschutz, insbesondere die Abfallbeseitigung sein, sondern auch die Leiter von einschlägigen Produktionsbetrieben und der Einkauf.

VCI-Abfallbörse

Wenn Sie sich für die folgenden Angebote oder Nachfragen interessieren, schreiben Sie bitte unter der Chiffre-Angabe an den Verband der Chemischen Industrie e. V. – Abfallbörse –, 6 Frankfurt 2, Postfach 119 081. Ihr Schreiben wird sofort an die betreffende Firma weitergeleitet.

Angebote

A245) Calciumcarbonat, ca. 80%ig mit etwa 10% freiem Kohlenstoff
Richtanalyse:

$CaCO_3$		75 – 80%
$Ca(OH)_2/CaO$	ca.	5%
SiO_2	ca.	1%
freier C	ca.	10%

Flußspat, Mg- und Fe-Oxid, N-haltige organische Verbindungen, Wasser unter 0,1%
Farbe: tiefgrau bis schwarz
Korngröße: ca. 90% unter 63 μ
Menge: einige 100 t/Monat
Raum: Bayern

A246) Schlamm aus der Trockenadsorption der Wasserregeneration mit etwa 20 % Fluor, Wassergehalt bei ca. 105° etwa 49 %
Durchschnitts-Trockenanalyse:

H_2O (Hydratwasser)	5,66 %
Al_2O_3	15,70 %
AlF	6,17 %
CaF_2	32,15 %
MgF_2	6,63 %
$CaSO_4$	13,06 %
$CaCO_3$	1,27 %
SiO_2	1,26 %
Na_2O	5,00 %
C	9,70 %
Fe_2O_3	1,27 %

Menge: 600 t/Monat
Raum: Nordrhein-Westfalen

A247) Ammoniumnitratlösung, ca. 2–2,5 molar mit Spuren von Uran
Menge: ca. 500 m³/Jahr
Raum: Hessen

A248) Nickelsulfat, fest bis schlammförmig
ca. 25 % Nickel im getrockneten Rückstand
Menge: ca. 20 Fässer à 200 l pro Jahr
Raum: Köln

A249) Natronsalpeter, verunreinigt mit ca. 6 % $NaNO_2$
Spuren von Fe, Cr, Ca, Ni
Menge: ca. 1,2 t/Monat
Raum: Köln

A250) Heißverformbares Schwerbeschichtungsmaterial
Granulatform, (Wiederholung von A171)
aus 12,5 % eines hochwertigen Kautschuks,
2,5 % Polystyrol sowie Gummihilfsstoffen, Füllstoffen
Menge: ca. 7000 kg einmalig, in Säcke abgepackt
Raum: Hessen

A251) Naphthalin mit Tetralin verunreinigt
Menge: ca. 2 t/Monat
Verpackung: 200 l Spannringfässer
Raum: Nordrhein-Westfalen

A252) Kaliglimmer (Muscovit) wasserfeucht
(Teilchengröße: <5 μ)
folgender Zusammensetzung: ca. 60 % Glimmer
ca. 2–3 % Natriumchlorid
Rest Wasser
Menge: ca. 20 t/Monat
Verpackung: nach Absprache
Raum: Rhein-Main-Gebiet

A253) Zink-Kalkgemisch

Wassergehalt	ca.	50–60 %
Zink	ca.	20 %
Calcium	ca.	5 %
Papierreste	ca.	2 %

Menge: 10–15 t/Monat
Verpackung: 10-t-Container
Raum: Nordrhein-Westfalen

A254) Regeneriertes Lösungsmittelgemisch aus Methylenchlorid und Aromaten, flüssig,
Menge: sporadisch 9000 l
Verpackung: lose bzw. Fässer
Raum: Köln

Source: *Chemische Industrie,* monthly journal of Germany's Chemical Industry Association.

UK WASTE MATERIALS EXCHANGE

Contact Request Form 1

Company Name:	**Address:** **Tel. No:**	**Contact:**
This Company Information is Confidential and Will Not Be Publicly Disclosed		

I am interested in obtaining the following items listed in the available section of the bulletin:
(N.B. The reference numbers of these items should begin with the letter A).

Ref. No. †	Quantity #	Description †

Contact Request Form 2

Company Name:	**Address:** **Tel. No:**	**Contact:**
This Company Information is Confidential and Will Not Be Publicly Disclosed		

I am able to supply the following items listed in the wanted section of the bulletin:
(N.B. The reference numbers of these items should begin with the letter W).

Ref. No. †	Quantity #	Description †

Contact Request Form 3

Company Name:	**Address:** **Tel. No:**	**Contact:**
This Company Information is Confidential and Will Not Be Publicly Disclosed		

I am also interested in obtaining the following items listed in the wanted section of the bulletin:
(N.B. The reference numbers of these items should begin with the letter W).

Ref. No. †	Quantity #	Description †

FIGURE A–2 U.K. FORMS FOR INQUIRING ABOUT WASTE OFFERS AND REQUESTS

Some variations of this basic pattern exist. Lists of the Nordic clearinghouse, for example, include offers not only of scrap wastes, but also of surplus stocks and plant capacity for recycling or disposal. It also conducts research and provides technical advice on improving the quality of wastes, so as to facilitate recycling. About 200,000 Swedish crowns ($46,000) are available for laboratory work or a pilot demonstration. The Danish Federation of Industries, for example, learned of acid wastes from the medical industry which seemed potentially suitable for acid pickling in the iron industry, except for trace organics and other impurities; a pilot demonstration removed the troublesome impurities, and once it was shown to work well, the transfer was completed.

Clearinghouses distinguish between two types of material: continuous waste, produced by a plant's normal operations; and occasional or episodic wastes in odd lots, for example products failing to meet specifications, surplus inventory, and products damaged in transportation or by fire or flood. Both continuous and episodic wastes are accepted for listing. However, if two partners find a continuous waste which each wishes to continue transferring, then they have no need of the clearinghouse service after its first referral; in time, therefore, clearinghouses are likely to receive greater proportions of episodic wastes, which may also be more difficult to transfer.

Germany's clearinghouse cannot, under that country's Waste Disposal Act of 1972, list materials designated as "wastes" (*Abfälle*), but only "residual materials" (*Rückstände*); in practice, this does not inhibit transfer, since the material's owner chooses the designation. The German clearinghouse handles neither waste oil nor radioactive wastes because their disposal is regulated strictly Moreover, its policy excludes residues for which there is already an established market, such as paper, plastics, textiles, and metal scrap.

The Nordic and U.K. organizations handle a broader range of wastes, which they classify as follows (United States SIC numbers of typical generators appear in aprentheses):

Nordic

Plastics (30)
Textiles (22) and Leather (31)
Paper—Containing Materials (26)
Solvents and Waste Oils (286, 29)
Acids and Pickling Liquors (281)
Inorganic Chemicals (281)
Organic Chemicals (286)
Slags, Sludges, etc.
Miscellaneous

United Kingdom

Acids and Alkalies (281)
Organic Chemicals and Solvents (286)
Metals (34)
Minerals (10, 14)
Oils and Waxes (29)
Paper and Board (26)
Rubber and Plastics (30)
Catalysts
Textiles (22) and Leather (31)
Food Processing (20)
Inorganic Chemicals (281)
Miscellaneous

The Nordic clearinghouse tries to avoid listing both established secondary materials and trash wastes clearly lacking productive value. The U.K. clearinghouse seeks a variety of participants, but does not list such easily marketable items as scrap metals or second-hand equipment.

U.S. VERSIONS OF THE EUROPEAN MODEL

In November 1975, after several months of planning by a volunteer task force, the St. Louis Regional Commerce and Growth Association (RCGA), analogous to chambers of commerce elsewhere, began its industrial waste clearinghouse service, the first in the United States, patterned after the European clearinghouses. Although the East-West Gateway Coordinating Council, a council of local governments in and around St. Louis, helped launch the clearinghouse by providing office space for the task force in its early days, it later withdrew in favor of the RCGA in recognition of industry's reluctance to provide potentially sensitive information to any organization associated with governments and their regulatory powers. RCGA staff spend only a few hours weekly preparing offers and requests for publication quarterly.

The volunteer task force, comprising about 18 persons from industrial companies, waste processing firms, consultants, and local and state governments, sets general policies and provides technical skills. Significant amounts of time, and thus professional skills and judgment, were contributed initially by some government officials, industrial companies, and consulting firms; for example, one senior environmental control engineer with a major chemical company, spent about 16 days over six months as chairman of the task force, and five or six other persons spent one or two days monthly. Other forms of hidden subsidies, not formally logged as costs but important, are the secretarial time, telephone bills, and duplicating costs incurred by these volunteers' companies. Moreover, the list, in addition to being mailed directly to some 500 names throughout the nation, is to be published without charge by several Missouri industry and environmental journals. Still more important for the clearinghouse's credibility with industry is the approval and professional endorsement of major local companies. Thus, the full start-up and operating costs are not known accurately even by its sponsors. Federal and state governments have not provided any direct support.

The first list (Table A-4) contained 43 offers and eight requests, more than the organizers had expected. Nineteen of the 51 listings came from beyond the St. Louis area, and as far as the east and west coasts. Moreover, during its first three months, the clearinghouse received some 350 inquiries about its procedures, eligibility of specific wastes, and possibilities for reciprocal arrangements with civic and private groups wanting to offer comparable services elsewhere.

TABLE A-4

FIRST LIST (EXCERPTS) FROM ST. LOUIS CLEARINGHOUSE

ITEMS AVAILABLE (TOTAL = 43)

Code Identification: A1-1

Item: Coated Abrasive Scrap-Mixed Pieces/Sizes, both cloth and Paper Backings; Grit Range 16-400 Unsorted.
Availability: Ten Tons per Month, 350 Pound Bales.
Location: Mid-South.

Code Identification: A1-2

Item: Spent Nitric Acid Strip with Approximately 1½ Pounds Copper Metal per Gallon Plus ½ Pound Nickel Metal per Gallon.
Availability: 3,000 Gallons at this Time.
Location: Local.

Code Identification: A1-3

Item: Centrifuge Cake-10% Plus Moisture; Solids-Approximately 84% Sand, 14% Glass, 2% Iron. Average Particle Size 20 Microns.
Availability: 200 Tons per Week.
Location: Local

Code Identification: A1-4

Item: Thermoplastic Resins, Reground; Various Types and Colors. Contaminated from 1% to 50%; Average Contamination 5% with Other Resins. Average Particle Size 3/16 Inch Diameter.
Availability: 50,000 Pounds per Month.
Location: Midwest.

ITEMS WANTED (TOTAL = 8)

Code Identification: W1-1

Item: Liquid Caustic Soda 25-50% by Weight/Volume.
Quantity Desired: Not Specified.
Location: Local.

Code Identification: W1-2

Item: Organic Waste Solvent-Ketones, Aromatics, Aliphatic, Chlorinated Solvents, Alcohols, or Blends of Same. Must Contain 60% or Higher Solvent and be Pumpable by Normal Means.
Quantity Desired: 7,000 Gallons per Day.
Location: Local.

Code Identification: W1-3

Item: Tin By-Products or Waste Products with 10-15% Tin or Higher.
Quantity Desired: 25-50,000 Pounds per Week.
Location: East Coast

Code Identification: W1-4

Item: Spent Nickel Catalyst Containing 10-12% Nickel, Dry Basis, or More.
Quantity Desired: 200,000 Pounds per Month.
Location: East Coast.

Source: St. Louis Regional Commerce and Growth Association, February 1976.

Other clearinghouses are in early stages of planning or operations at Iowa State University, the State of Washington, and the Houston Chamber of Commerce.

OPERATING EXPERIENCE

Comprehensive and accurate data about wastes and transfers are difficult to obtain, due mainly to needs of confidentiality and incomplete follow-up of referrals. Four older and larger clearinghouses, however, have analyzed and reported some numerical data:[19-22]

	Listings	Inquiries	Transfers Completed via Clearinghouse
Netherlands (1st 18 months)	80	Not available	9
Germany (2nd 100 listings)	100	375 (for 70 items)	18
Scandinavia (1st 10 months)	142	250	5
United Kingdom (1st year)	833	2,640 (for 618 items)	54

Clearinghouses cannot always obtain complete information from clients on the results of referrals; moreover, some materials, even though listed,find users through channels other than the clearinghouse.

Data in reports, lists, and interviews showed a number of patterns common to clearinghouses in Europe and St. Louis:

- Their periodic lists (weekly to quarterly) usually carry many more offers than requests.
- Only about ten percent of wastes offered are transferred.
- Of those transferred, a large proportion are recognized by-products, such as concentrated acids, certain catalysts, and residues with high contents of metals.

- A large proportion, both in number and in volume, of wastes offered but not transferred are materials such as dilute acids and ferrous sulfate; although these have potential uses, they are often too low in value, too diluted, or offered in quantities too small to justify transportation or reprocessing costs.

- Major barriers to successful transfer are transport costs, too low a concentration of valuable material, and impurities too costly to remove; the last problem points to the importance of generators keeping wastes separated, rather than mixing them, so as to facilitate analysis, matching, and reprocessing.

- Major receivers of scrap wastes transferred via clearinghouse referral appear to be chemical dealers and reclaimers, which suggests that they reprocess the materials before selling them to ultimate users.

- Continuous waste streams offered are far greater, in number and volume, than one-time offers of off-specification or damaged materials.

- Volume of activity on the older clearinghouses declined after an early peak, which suggests that (1) the backlog of transferrable scrap wastes was worked down and (2) trading partners identified to each other by clearinghouses later continued to negotiate transfers directly.

- The more likely clients for the clearinghouse service are companies with little or no technical skills in industrial chemistry.

- Useful functions performed by clearinghouses, in addition to identifying scrap wastes and introducing generators and users, are (1) educating industry generally about possibilities of waste transfers, (2) broadening the markets for chemical reclaimation firms, and (3) collecting inventory data, incomplete but better than now available, about both scrap wastes available for transfer and trash wastes needing disposal.

In addition to these points which appear to be common to most clearinghouses, some highlights relate to only one. In the Netherlands, a firm designing a new plant asked the Dutch clearinghouse which of the several production processes being considered generated wastes which might be transferred successfully via the clearinghouse. The German clearinghouse pursues a strict policy of not listing wastes which are clearly trash; consequently, it shows a success rate higher than those of other clearinghouses, with almost 20 percent of listings leading to transfers. In the United Kingdom, savings to industry clearinghouse-assisted transfers are estimated to be about £2 million (about $3.6 million), which vastly exceeds the clearinghouse's operating cost.

ADVERTISING WASTES IN TECHNICAL JOURNALS

In France, *Nuisances et Environnement* began in 1974 a column listing offers and requests (Table A-5). Advertisers are asked to indicate quantity and composition of materials, frequency of availability, and general geographic location. The response was initially small, but has reportedly increased since the formation of the French clearinghouse, which now publishes listings both in this journal and in another, *Chimie-Actualités*. In Japan, a chemical monthly charges companies $30 for an advertisement indicating the waste's characteristics, quantity, and location. In Canada, *Canadian Chemical Processing* publishes ads free of charge; thus, the column produces revenue only to the extent that its availability increases purchases of the journal. In 1974 and 1975, it listed only six-to-eight notices yearly.

Chemical journals often carry advertisements for surplus raw materials and byproducts; these columns could also advertise scrap wastes.

Unlike the official clearinghouses, the technical journals do not appear to screen listings for appropriateness or to follow their referrals to learn the results. They do help, however, to collect information that could be used by potential clearinghouse operators to gauge the market, and to educate generators and potential users about the possibilities of transferring wastes.

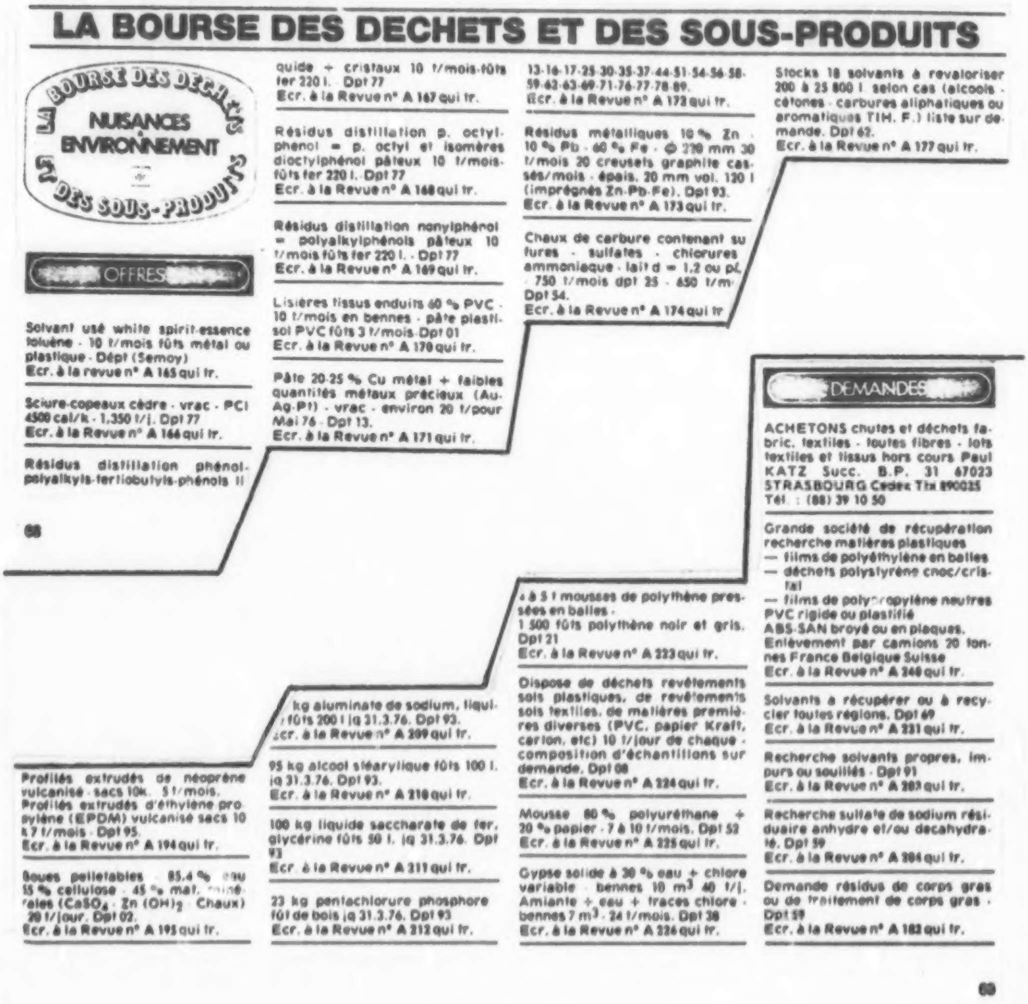
COMMERCIAL VARIATIONS

Two new services may demonstrate in time the market potential for a type of transfer service which is neither subsidized on the European model nor capital-intensive as are materials exchanges, but which can survive as an economically viable enterprise.

The Natural Resource Recycling Exchange, Boston, Massachusetts, was organized in late 1975 by men experienced in advertising, banking, and commodity trading. They conceive of a data bank large enough to justify handling by a computer programmed to match offers and requests. They plan to retain scientific or engineering consultants to seek or develop uses for wastes without readily apparent uses. Although the sole purpose of this enterprise is to transfer information, it differs from the European and St. Louis clearinghouses in three ways. First, it is a profit-seeking venture, charging fees in the manner of stock or commodity exchanges: clients must pay one fee to join the service, another each time they enter an offer or request into the computerized data bank, and a commission on each transfer completed successfully. Second, it is not supported, financially or professionally, by industry associations or government laboratories; thus, it may lack the free access to technical talents which other exchanges use to identify wastes and possible reuses;

TABLE A-5

SAMPLE LIST (PARTIAL) FROM FRENCH CLEARINGHOUSE



LA BOURSE DES DECHETS ET DES SOUS-PRODUITS

LA BOURSE DES DECHETS ET DES SOUS-PRODUITS
NUISANCES ENVIRONNEMENT

OFFRES

Solvant usé white spirit-essence toluène - 10 t/mois fûts métal ou plastique - Dépt (Semoy)
Ecr. à la revue n° A 165 qui tr.

Sciure-copeaux cèdre - vrac - PCI 4500 cal/k - 1,350 t/j. Dpt 77
Ecr. à la Revue n° A 166 qui tr.

Résidus distillation phénol-polyalkyls-tertiobutyls-phénols li

68

quide + cristaux 10 t/mois-fûts fer 220 l. - Dpt 77
Ecr. à la Revue n° A 167 qui tr.

Résidus distillation p. octyl-phenol = p. octyl et isomères dioctylphénol pâteux 10 t/mois-fûts fer 220 l. - Dpt 77
Ecr. à la Revue n° A 168 qui tr.

Résidus distillation nonylphénol = polyalkylphénols pâteux 10 t/mois fûts fer 220 l. - Dpt 77
Ecr. à la Revue n° A 169 qui tr.

Lisières tissus enduits 60 % PVC - 10 t/mois en bennes - pâte plastisol PVC fûts 3 t/mois-Dpt 01
Ecr. à la Revue n° A 170 qui tr.

Pâte 20-25 % Cu métal + faibles quantités métaux précieux (Au-Ag-Pt) - vrac - environ 20 t/pour Mai 76 - Dpt 13.
Ecr. à la Revue n° A 171 qui tr.

13-16-17-25-30-35-37-44-51-54-56-58-59-62-63-69-71-76-77-78-89.
Ecr. à la Revue n° A 172 qui tr.

Résidus métalliques 10 % Zn - 10 % Pb - 60 % Fe - Ø 220 mm 30 t/mois 20 creusets graphite cassés/mois - épais. 20 mm vol. 120 l (imprégnés Zn-Pb-Fe). Dpt 93.
Ecr. à la Revue n° A 173 qui tr.

Chaux de carbure contenant sulfures - sulfates - chlorures ammoniaque - lait d = 1,2 ou pl. - 750 t/mois dpt 25 - 650 t/m Dpt 54.
Ecr. à la Revue n° A 174 qui tr

Stocks 18 solvants à revaloriser 200 à 25 800 l selon cas (alcools - cétones - carbures aliphatiques ou aromatiques TIH. F.) liste sur demande. Dpt 62.
Ecr. à la Revue n° A 177 qui tr.

Profilés extrudés de néoprène vulcanisé - sacs 10k. 5 t/mois.
Profilés extrudés d'éthylène propylène (EPDM) vulcanisé sacs 10 k 7 t/mois - Dpt 95.
Ecr. à la Revue n° A 194 qui tr.

Boues pelletables - 85,4 % eau 15 % cellulose - 45 % mat. minérales ($CaSO_4$ - Zn $(OH)_2$ - Chaux) 20 t/jour. Dpt 02.
Ecr. à la Revue n° A 195 qui tr.

kg aluminate de sodium, liqui fûts 200 l jq 31.3.76. Dpt 93.
Ecr. à la Revue n° A 209 qui tr.

95 kg alcool stéarylique fûts 100 l. jq 31.3.76. Dpt 93.
Ecr. à la Revue n° A 210 qui tr.

100 kg liquide saccharate de fer, glycérine fûts 50 l. jq 31.3.76. Dpt 93
Ecr. à la Revue n° A 211 qui tr.

23 kg pentachlorure phosphore fût de bois jq 31.3.76. Dpt 93
Ecr. à la Revue n° A 212 qui tr.

4 à 5 t mousses de polythène pressées en balles -
1 500 fûts polythène noir et gris. Dpt 21
Ecr. à la Revue n° A 223 qui tr.

Dispose de déchets revêtements sols plastiques, de revêtements sols textiles, de matières premières diverses (PVC, papier Kraft, carton, etc) 10 t/jour de chaque - composition d'échantillons sur demande. Dpt 08
Ecr. à la Revue n° A 224 qui tr.

Mousse 80 % polyuréthane + 20 % papier - 7 à 10 t/mois. Dpt 52
Ecr. à la Revue n° A 225 qui tr.

Gypse solide à 30 % eau + chlore variable - bennes 10 m^3 40 t/j. Amiante + eau + traces chlore - bennes 7 m^3 - 24 t/mois. Dpt 38
Ecr. à la Revue n° A 226 qui tr.

DEMANDES

ACHETONS chutes et déchets fabric. textiles - toutes fibres - lots textiles et tissus hors cours Paul KATZ Succ. B.P. 31 67023 STRASBOURG Cedex Tlx 890025 Tél. : (88) 39 10 50

Grande société de récupération recherche matières plastiques
- films de polyéthylène en balles
- déchets polystyrène choc/cristal
- films de polypropylène neutres

PVC rigide ou plastifié
ABS-SAN broyé ou en plaques.
Enlèvement par camions 20 tonnes France Belgique Suisse
Ecr. à la Revue n° A 240 qui tr.

Solvants à récupérer ou à recycler toutes régions. Dpt 69
Ecr. à la Revue n° A 231 qui tr.

Recherche solvants propres, impurs ou souillés - Dpt 91
Ecr. à la Revue n° A 203 qui tr.

Recherche sulfate de sodium résiduaire anhydre et/ou decahydraté. Dpt 59
Ecr. à la Revue n° A 204 qui tr.

Demande résidus de corps gras ou de traitement de corps gras - Dpt 59
Ecr. à la Revue n° A 182 qui tr.

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Source: *Nuisances et Environnement,* January/February 1976.

it may also find difficulties in overcoming reluctance of some waste generators and potential users to deal with an organization of unknown reputation. Third, in order to sell enough services to survive economically, it cannot wait passively for clients to call in waste offers or requests; instead, it must go into the marketplace to promote services and seek clients actively.

Trans Chemical Corporation, a Miami-based chemical trader began in late 1975 to offer a computerized matching service, "Chemscan", which monitors about 250 chemical products. Companies can submit offers and requests without charge. These appear weekly in a computer printout of about 1,200 buy-and-sell orders, bought by about 150 subscribers at a price of $15 a week. Interested subscribers can then contact each other to negotiate deals directly.

"Chemscan" lists chemical products rather than scrap wastes. However, this or a similar service could be extended to scrap wastes if the market proved large enough. The fee of $15 per week, or $780 per year if 52 lists are issued, yields a gross income of $117,000 if 150 subscribers remain the full year; this is presumably high enough either to cover costs and return a profit, or at least to cover most costs for a service which Trans Chemical considers an effective "loss leader", a technique for attracting clients for other lucrative services. The major attraction of "Chemscan" is volume–using its computer to collect and display far more information to many more customers than can the ordinary broker with paper and pencil roving the floor of a commodity exchange. For subscribers, their chances of identifying suitable trading partners make the $15 per week fee well worthwhile; in fact, many probably cannot afford to pass up such chances for such a low price. Similarly, the St. Louis and European clearinghouses could tally their costs accurately and then design a schedule of both listing and subscription fees according to their estimates of the numbers of listers and subscribers willing to pay; the rate schedule could be designed merely to cover costs exactly, or to return a surplus or profit which would help finance such other services as limited technical consulting.

Trans Chemical no doubt tries to sell its "Chemscan" service widely. However, it remains a passive form of clearinghouse, since after listings are published the initiative for bringing trading partners together rests entirely with themselves. From a business viewpoint, such a listing service has little direct interest in whether material is later transferred, because its economic survival depends on collecting its listing and subscription fees.

APPENDIX B

MATERIALS EXCHANGES

CHARACTERISTICS

A few small companies offering a broad range of chemical reclamation and consulting services are also serving, or interested in serving, as materials exchanges. Examples exist in both Europe and the United States; the examples given below are intended only to illustrate this type of transfer agent and not to suggest that these are the only companies engaged in activities relevant to transferring scrap wastes.

The number of true materials exchanges is smaller than that of information clearinghouses. A key characteristic is that these exchanges were begun and are operated by persons who are both entrepreneurs and have extensive knowledge and experience in chemical processing. Because the exchange service is difficult and risky, it is typically offered together with other services. Details of the financial and technical operations of existing exchanges are not known, since these are private business organizations and do not publish lists of scrap wastes available. It is clear, however, that both technical knowledge and imagination are essential requirements for success.

TWO EXAMPLES

A Dutch Company: Wimborne-CPR

Wimborne-CPR is a chemical processing and reclamation firm. It was formed as a joint venture between Wimborne Chemicals Ltd., a British chemical reclamation company, and Centrale Potas Raffinaderij, whose principal activity today is trading in potassium and sodium carbonates and other salts. It has a close working relationship with the Dutch information clearinghouse and in many ways complements the latter's efforts.

The company originated from an interest in diversifying on the part of CPR, whose potassium carbonate extraction operations had declined. Discussions with the Dutch Industries Federation and with government authorities led to the idea of using CPR's resources to reclaim valuable products from waste materials. In the course of subsequent market research, CPR made contact with Wimborne Chemicals, and the companies decided on an association.

Both of the joint-venture partners are members of larger groups: Wimborne is part of the Shirley Aldred group, which in the past has had interests in wood chemicals and today has strong interests in activated carbon; CPR is ultimately held by the Dutch sugar industry (two companies), although until 1965 the Belgian sugar industry also participated. This matrix of relationships within the two parent groups enables Wimborne-CPR to provide a comprehensive chemical waste reclamation service with little, if any, technical staff of its own and limited processing facilities. For much of the latter, it uses subcontractors, mainly located in the Netherlands, the United Kingdom, and Belgium. Some of these are major chemical companies with spare capacity. Thus, the company's activity consists largely of using its contacts and affiliations to provide technical and processing solutions on a case-by-case basis. It is the only Dutch company performing such a service on a large scale.

Part of the company's role is furnishing advice to companies with disposal problems. It tries to become involved at the earliest possible stage, since it can then propose solutions which render the materials capable of processing. For example, one company had built a huge storage tank which received three incompatible waste streams, including paint and machine-tool lubricants. The company wanted someone to take a regular quantity of the contents for reprocessing, but approached Wimborne-CPR only when the tank was well on the way to being full. Had each of the three streams been channeled to separate tanks, they might all have had appreciable value for reprocessing.

Wimborne-CPR sees itself as providing the commercial link (i.e., at a profit) between buyers and sellers of chemical wastes, a role which is essential but which the Dutch information clearinghouse does not attempt to fill. Offers of waste material received by the clearinghouse are sent immdediately to Wimborne-CPR, which accounts for a large share of the transfers actually completed with aid from the clearinghouse. While the clearinghouse is an important source of offers and requests, Wimborne-CPR also gets them directly as a result of its numerous contacts in the process industries. Wimborne-CPR does not advertise, although it does issue a small, two-page promotional pamphlet.

The company's services are paid for both by the company generating waste chemicals and by the buyer of the purified products.

Zero Waste Systems, Oakland, California

Newer and smaller than Wimborne-CPR, Zero Waste Systems (ZWS) also offers a broad range of services. ZWS was founded in 1973 by a physical chemist. The staff includes a chemist, support persons for lab and office work, and a network of Bay Area consultants. ZWS offers to handle surplus chemicals, collect industrial processing wastes, sell recycled and surplus materials, and provide consulting aid in minimizing waste control problems. Thus, ZWS is both a materials-handling exchange and a surplus chemicals dealer and consulting firm specializing in industrial processing wastes. ZWS appears to operate on tight profit margins and to depend for success upon technical experience, imagination, many industrial contacts, a keen knowledge of current markets and prices, and entrepreneurial vigor in finding and pursuing market opportunities. ZWS, like Wimborne-CPR, farms out much work to chemical job shops or plants with spare capacity. ZWS's objective is to neutralize or find new markets for *all* industrial wastes, rather than to dispose of them into the environment.

Several aspects of ZWS's business environment or circumstances deserve mention for the guidance of potential exchange operators elsewhere. A major assist comes from California's hazardous waste control law and regulations, which require generators to report in detail on all wastes sent out for disposal. Plant managers, to save the cost and bother of lengthy reporting, prefer to sell or even give wastes to ZWS. (However, ZWS can survive by accepting only those wastes containing scrap materials of known value. It does not accept, for example, dilute sulfuric acid or chromic acid, for which there is little or no market.)

Another and related major assist comes from the Bay Area public's environmentally-conscious attitude. ZWS receives much free publicity from local news media. It is aided at working levels of many companies by technicians who make an extra effort to send wastes to ZWS rather than to disposers. Zero Waste receives many referrals from state and local agencies which do not know how to handle hazardous wastes.

Public attitudes, the wealth of technical talent in Berkeley, and the concentration of industrial plants all make the Bay Area ideal for ZWS. Although the firm reports that it often has more work than its staff of five can handle, demand is not stable enough at high enough levels to permit an increase in staff. Los Angeles offers a larger industrial concentration and market area and would be a logical candidate for future expansion. Although most transfers probably occur within the Bay Area, ZWS reports occasional shipments as far as Texas when the economics of the transfers are favorable enough. Part of the ZWS business strategy is not to limit itself, as do some dealers, to only one industry or area, but rather to offer services to many industries and nationally.

Another part of its business strategy is to fill a gap in the chemical materials market structure by serving the needs of companies which either choose not to or do not know how to transfer scrap wastes in small quantities. This suggests, as does some information from Europe, that the most likely customers for transfer services, both information and materials, are companies with little or no technical skills in industrial chemistry.

However sound its business strategy in theory, ZWS seconds the experience of others that the materials exchange staff must be persistent and aggressive both in identifying waste and in finding appropriate matches. Its staff sometimes meets generators who at first do not recognize having significant wastes in their plants, only to do so later in the conversation when asked about them specifically; generators are not trying to cover up the existence of wastes, but simply overlook them in response to the initial question. Indeed, it is quite logical that processing residues intended for disposal are not perceived by generators as "scrap chemicals" having reuse value. This illustrates the importance which attitudes play in recognizing scrap value in wastes, and thus in seeing the usefulness of an exchange. It also underscores the importance of keeping wastes segregated, so as to facilitate analysis, matching, and transfer.

Zero Waste Systems prides itself on being a small and innovative enterprise. It sees itself pioneering a new industry, and offering the best model for a waste materials exchange. It foresees a national network of regional waste exchanges. Its own need now is for a major data bank to support its technical procedures and entrepreneurial skills developed during its first two years.

A NEW EXCHANGE CONCEPT

The newly opened American Chemical Exchange does not transfer scrap wastes. Yet it deserves mention because it is trying to prove an exchange concept and procedures which may be useful for materials exchanges which deal in wastes.

American Chemical Exchange, Inc. (ACE), of Skokie, Illinois, resembles Trans Chemical's "Chemscan" service (Appendix A) in featuring a computerized matching service and mass exposure of information. It also specializes, by making trades only in about 75 manufactured chemical products. But whereas Trans Chemical is only a modern classified ad service transferring information, ACE is a broker interposed between buyer and seller.

A majority of ACE's clients are small companies. They join ACE by paying a fee ($250) analogous to the subscription fee for "Chemscan" and the membership fee for the National Resources Recycling Exchange (Appendix A). With 90 clients in early 1976, 50 inquiries each day, and the eventual possibility of 1000 clients, ACE could have a financial base of $250,000. But the important source of its income will come from commissions, ranging between 1% and 5%, on any trade it makes. After placing a firm order, a seller must deposit 10% of the sales price into an escrow account to ensure availability of the chemical. Similarly, a buyer must deposit the entire purchase price into the escrow account within 24 hours. ACE thus performs a needed intermediary role to resolve the constant question of whether goods or payment should move first.

As in a stock exchange, buyer and seller do not know each other but negotiate only through ACE. Once a deal is struck, ACE handles the transfer of both funds and the chemicals to keep identities secret. This classes ACE as a materials exchange. However, the functional requirements for transferring a manufactured product are less than those for a scrap waste. With a standard product, the seller, buyer, and exchange all know its characteristics, which are backed by a warranty and the reputation of the seller and ACE. But with a waste—almost never standard—its characteristics must be specially analyzed so that the potential users can judge according to their process specifications. Thus, technical compatibility requirements exist for both a product and a waste, but in paractice ACE is able to perform mainly as an information and financial broker, while a waste materials exchange like Wimborne-CPR must also perform analytical and reclamation functions. Although ACE now has the information technology and brokerage skills for extending its services to include scrap wastes, it would have to add the technical and marketing skills required to deal successfully in these materials. Moreover, it would of course have to see attractive processing profit opportunities in the business of brokering wastes, which is inherently more risky than the business of brokering manufactured chemicals.

However, ACE's best market seems similar in an important respect to the natural market of waste exchanges. Large chemical companies have within their staffs enough knowledge and skills to identify and arrange their own spot trades. But these functions often strain the capacities of smaller companies, which are therefore forced to seek help from a broker.

APPENDIX C

DATA AND METHODS

IDENTIFYING SCRAP WASTES AND THEIR USES

Recognizing and verifying a potential use for an industrial waste constitute the heart of the transfer process. It is a creative act, since it makes possible something which did not seem possible before; the discovery of value in a waste previously considered as trash is the first step in transforming it into scrap.

Therefore, experience, knowledge of chemical processing, and, especially, imagination are essential for identifying possible uses for wastes. Naturally, published sources can stimulate the imagination, and young graduate chemists and chemical engineers can assist in initial screening steps. But there are no substitutes for practical processing expertise and first-hand knowledge of industrial practices. Of course, no one person, or even a small group, can be familiar with detailed operating practices and the many industries which might use wastes. So, a variety of experts should be consulted to help verify initial judgements and to assess the economic and technical feasibility of potential transfer opportunities. (However, expertise can result in negativism—emphasis on reasons why new ideas cannot succeed and should not be tested. This is why imagination, and some courage, are essential qualities.)

Various publications can help in initial identification of potential uses. The main ones are:

- *Chemical Week* in every issue groups classified ads under the headings: "Chemicals for Sale/Wanted", "Chemicals for Sale", and "Chemicals Wanted". Most ads are to buy or sell surplus chemicals. A few, mostly from dealers and reprocessors, request chemical wastes. Occasionally, an offer appears for waste materials. The requests recently have been for solvents, spent catalysts (Co-Cu, Cu-Zn, Cu-Cr, etc.), slurries and sludges with a minimum 30% metallic content, ethanolamines, and glycols.

- *Chemical and Engineering News* is useful mainly for current information on prices and supplies of chemical commodities, which should be monitored closely.

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- *Chemical Marketing Reporter*, is useful mainly for determining demand and price trends for chemicals. As demand and price increase, the economic feasibility of recovering the valuable components from waste materials improves

- *The Merck Index of Chemicals and Drugs*, New Jersey: Merck & Co., Inc.

- *Chemical Origins and Markets*, Menlo Park, Cal.: Stanford Research Institute, Chemical Information Services, 1967; includes product flow charts and tables of major organics and inorganics.

- Stanford Research Institute, *Directory of Chemical Producers—United States of America*, Menlo Park, Cal.: SRI.

- *Kirk-Othmer Encyclopedia of Chemical Technology*, 2nd ed., 6 v., New York, Interscience Publishers, 1963.

- Considine, Douglas M., *Chemical and Technology Process Encyclopedia*, New York: McGraw-Hill.

- *Hackh's Chemical Dictionary*, Fourth Edition, revised and edited by Julius Grant. McGraw-Hill, New York, 1969.

- *The Van Nostrand Chemist's Dictionary*, D. Van Nostrand Company, Inc. Princeton, New Jersey, 1953.

- *The Encyclopedia of Chemistry*, Third Edition, edited by Clifford A. Hampel and Gessner G. Hawley, Van Nostrand Reinhold Co., New York, 1973.

  These dictionaries list industrially-produced chemicals and their uses. A dictionary is entered according to the principal component of the waste. Potential uses are selected by engineering judgment about the sensitivity of the use to the waste's purity. In general, the less critical purity is to the use, the greater the possibility for using the waste "as-is", or with only minor pretreatment.

- R. Norris Shreve's, *The Chemical Process Industries*, (New York: McGraw-Hill), a classic textbook, provides flow diagrams and raw materials requirements. Those wastes which appear to match the properties raw materials in a process represent potential substitutes.

- EPA's national industry studies[8–18] also provide process flow diagrams and descriptions of raw materials feedstocks.

Table C-1 lists a sample of processes, their wastes, and potential uses for the wastes. This list is by no means exhaustive; it was developed both to explore uses for wastes described by EPA's industry studies, and to suggest possibilities to Philadelphia plant managers during interviews. Many more wastes and uses appear in two categories (organics and inorganics) than in the six others (acids, alkalis, oils and waxes, catalysts, polymers and resins, and miscellaneous); this imbalance does not reflect the actual proportion of transfer opportunities among industries, but rather variations in the data bases available.

A SAMPLE TRANSFER AREA: THE PHILADELPHIA SMSA

Characteristics, Industries, and Wastes

Standard Metropolitan Statistical Areas (SMSAs) are designated by the U.S. Bureau of the Census to standardize urban areas for purposes of consistency and comparisons. An SMSA's boundaries are drawn to include both a core city and its natural economic suburbs and hinterlands. The Philadelphia SMSA (Figure C-1) encompasses nine counties: Bucks, Chester, Delaware, Montgomery, and Philadelphia in Pennsylvania; and Burlington, Camden, and Gloucester in New Jersey; its urban core consists of Philadelphia and Camden. The SMSA measures about 60 miles along its major east-west and north-south axes. It abuts other industrially important SMSAs, Trenton, Allentown-Bethlehem-Easton, and Wilmington; moreover, Newark, Jersey City, Patterson-Clifton-Passaic lie 60 miles northeast.

The Philadelphia SMSA, the nation's fourth largest manufacturing area, contains industrial plants representing 98% of all Standard Industrial Code (SIC) categories. Principal industries include electroplating, foundries, inorganic chemicals, pharmaceuticals, paints, petroleum refining, and machinery manufacture. In the SIC categories considered by this study, there are 442 plants, of which most are small (Table C-2).

Table C-3 summarizes the types and quantities of wastes estimated from plants in various industry categories in the SMSA. These data were derived from the national waste data summarized in Tables III-1 and III-2, using as the scaling factor the number of employees in Philadelphia plants proportionate to the number in the industry nationally. While the data are not highly accurate due to uncertainties in local employment and the inherent variability of waste generation rates expressed on a per employee basis, it is clear that the largest number of plants in each industry category (with the exception of petroleum refining) employ under 100 people. Out of a total of 442 plants listed, only 28 or 6% employ

TABLE C-1a

GENERATION AND POTENTIAL USES OF SELECTED CHEMICAL WASTES

WASTES GENERATED			POTENTIAL USES
SIC	**Product Manufactured/Process**	**Waste Properties**	
2819	PCl_3	$HCl + P_2O_5$ in aqueous scrubbing liquor	Pickling and rustproofing metals
2819	Activated Carbon	H_3PO_4	Fertilizer manufacturing Electric plating
2812	Na_2CO_3/Trona or Solvay	$CaCO_3$, $Mg(OH)_2$ sludge	Alkaline wet scrubbing Filler for rubber
2813	Acetylene/Carbide	$Ca(OH)_2$ sludge	Alkaline wet scrubbing
2833	Penicillin	NaOH waste broths	Alkaline scrubbing Acid neutralization
2819	$Ca(OH)_2$	Lime and limestone solids	Alkaline scrubbing Acid neutralization
2821	LDPE/Hi-Pressure	Oils and Waxes	Candles Capacitor insulation Secondary plastics Mold Binder
2865	Styrene	Styrene, ethyl benzene tars	Mold core lubricant
2821	Polymer resins	Resins	Mold cores
2833	Antibiotics	Filter cell mycelium	Soil builder
2833	Penicillin	Filter cell mycelium	Soil builder
2833	Alkaloids	Wet plant material	Composting
3291	Crucibles and grinding wheels	SiC	Grey iron foundries

Source: Arthur D. Little, Inc.

TABLE C-1b

GENERATION AND POTENTIAL USES OF INORGANIC CHEMICAL WASTES

WASTES GENERATED			POTENTIAL USES
SIC	Product Manufactured/Process	Waste Properties	
2815	Phenol & Sulfonate	Na_2SO_3, Na_2SO_4 sludge	Paper manufacture
2816	ZnO/American	Fe_2O_3, FeO, MgO sludge	Ferrous smelting
2812	Na_2CO_3/Solvay	$CaCl_2$	Road salt
2818	Formic acid/Formate	Na_2SO_4 sludge	Paper industry Textile industry
2818	Glycerine/Allyl chloride	$CaCl_2$, NaCl Salts	Road salt
2819	Boric Acid	Na_2SO_4 sludge	Paper industry Textile industry
	Chromic Acid	Na_2SO_4 sludge	
	Hydrochloric Acid	Na_2SO_4 sludge	
	Sodium Sulfite	Na_2SO_4 sludge	
	Petrochemical Polymers	Attapulga clay and hydrated lime	Filler for rubber, paper, textiles
2813	Acetylene/Sachaser	Carbon black filter cake	Lead pencils Carbon dispersions
2819	NH_4Cl/Solvay	$CaCO_3$ filter cake	Wet scrubbing Rubber filler
	NH_4Cl/Solvay	Glauber's salt, $NaSO_4 \cdot 10H_2O$ (viewed as a by-product)	Textile industry
2819	KCl K KNO_3	NaCl cake	Textile industry Road salt
286	Aneline	Fe_3O_4 and tar	Steel mills
286	Chloral	$CaSO_4$ sludge	Cement Paint filler
2812	Sodium bicarbonate	Na_2CO_3, $NaHCO_3$ slurry	Acid neutralization Tanning Timber mold inhibitor
2813	Nitric oxide	Caustic, sodium nitrite solution	Dyeing Bleaching
2819	Chromic oxide	$Ca(OH)_3$	Metal recovery
2816	Iron Oxide pigments	$Fe(OH)_3$; Fe_2O_3 solids	Ferrous smelting
2819	Mercuric sulfide	HgO	Metal recovery
2819	NaF	CaF_2	Ceramics Flux Glass
2819	Beryllium hydroxide	Alum slurry	Paper Textiles Water treatment
2819	Nickel sulfate	$Ni(OH_2)$, filter acid	Metal recovery
2819	P_2O_5	$Ca_3(PO_4)_2$ sediment	Ceramics Polishing Mordent Cements
2819	PCl_3	$AsCl_3$ residues	Intermediate for organic arsenecals
2819	$KMnO_4$	MnO solid	Ferromanganese production Metal recovery
2819	$ZnSO_4$	MnO_2 solid	As above
2869	Epichlorohydrin	$CaCl_2$ solid	Road salt
2821	Methyl methacrylate	Na_2SO_4 filter cake	Paper Textiles
2819	Ferrous Sulfate	Copperas	Inks Pigments Fertilizer Water Treatment
2565	Phenol/cumene	Na_2CO_3	$PbCO_3$ manufacture Flux Glass manufacture
2816	TiO_2	$FeSO_4$	Manufacture of Iron blue Water Treatment Manufacture of Fe_2O_3 Pigments (dry process)
3321	Cast iron pipes	Slag	Cement block Cinder block

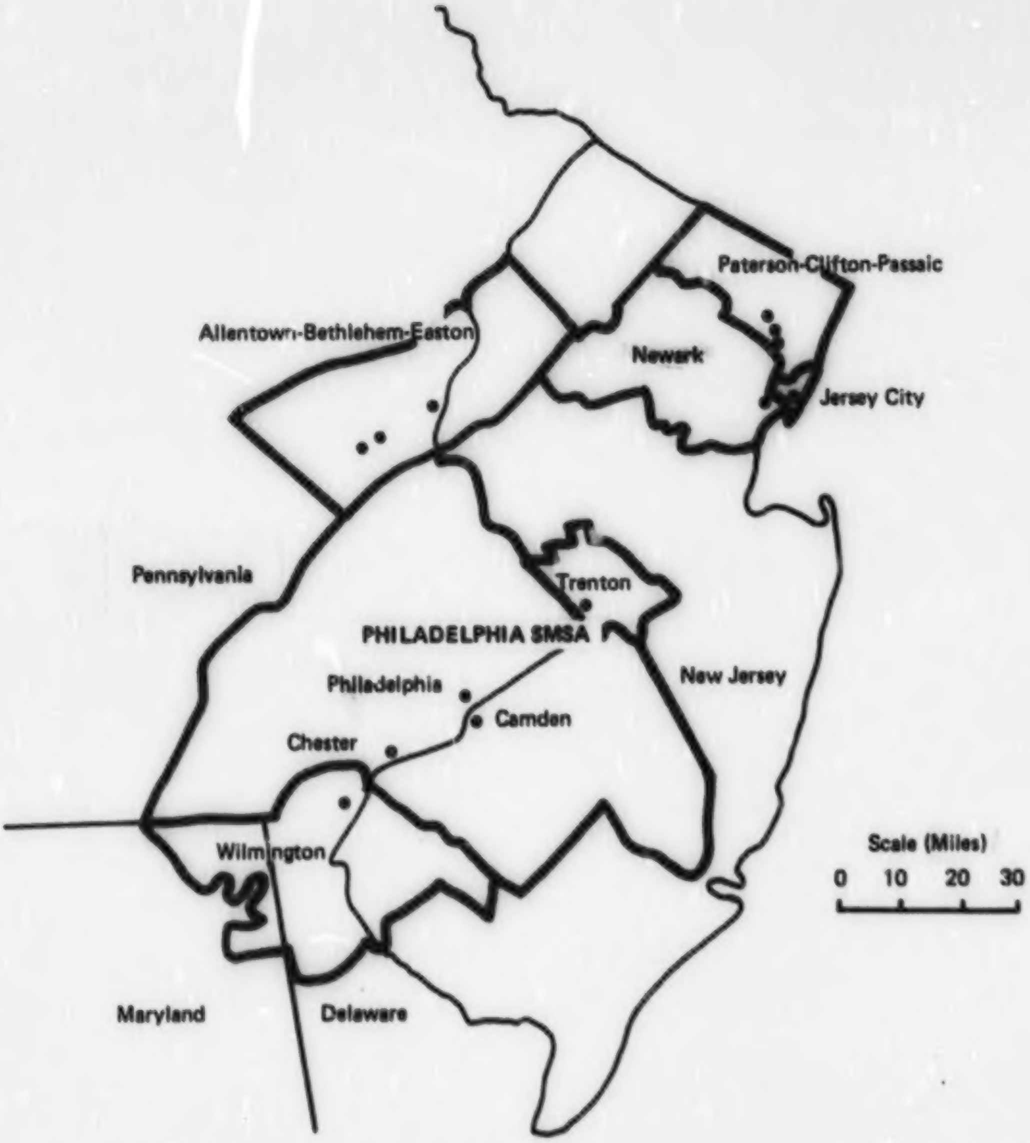
Source: Arthur D. Little, Inc.

TABLE C-1c

GENERATION AND POTENTIAL USE OF ORGANIC CHEMICAL WASTES

WASTES GENERATED			POTENTIAL USES
SIC	Product Manufactured/Process	Waste Properties	
2869	Ethylene Glycol	Glycols and water	Solvent reclamation
2865	Phenol	Phenol, cresol, off-spec in water	Wood preservative for boat or fence post manufacture
2865	Phenol/Cumene	Acetophenone, phenol, cumyl phenol evaporation residue	Wood preservative
2865	Iso and Tere-phthalic acids	Phthalic acid, toluic acid, benzoic acid, trimellitic acid, aldehydes, acetic acid, Bi, Mn, Co—still bottoms	Film forming in paint manufacture
2821	Acrylic acid	Aqueous acrylic acid and hydroquinone	Acrylic emulsion paints
2865	Phthalic anhydride/xylene	Ptralic anhydride/maleic anhydride tar	Polymeric binder for shingles wood chips, grinding wheels, retractory bricks, etc.
2865	Maleic anhydride	Maleic anhydride tars	Polymeric binder
2879	Carbaryl	Naphthol residues	Dye intermediate
2869	Aromatic amines	Long chain amines (solid)	Ore Benefication
2843	Surface active agents	C-8-C-18 fatty alkyl acids, nitriles, amines	Ore Benefication
2821	SANpolymers	Styrene and acrylonitrile	Film forming Molding Compounds
2869	Ethylene dichloride (EDC)	EDC, tri- and tetra-chloroethanes; sludge	Dry cleaning Degreasing of metal parts
2869	Hexachlorocyclobutadiene	Chlorinated toluenes, pentanes, benzenes	Degreasing solvents
2869	Perchloroethylene (Perc)	Perc., CCl_4 chlorined hydrocarbons-liquid still bottoms	Dry cleaning solvents Degreasing solvents
2833	Pharmaceuticals	Various solvent wastes–chlorobenzene, toluene, methanol, methylene, dichloride, tetrachloroethane	Solvent recovery Degreasing Cleaning Paints
2869	Sulfonic Acids	Emulsified oils and sulfones	Leather lubricant and treatment
2822	Urethane	Mixed polyols and phosphate esters	Molding compound Filler for wood, wallboard
2869	Tetraethylorthosilicate	Tetraethyl orthosilicate, iodine, alcohol, Genusolu D	Stone or concrete preservation Mortar Paints
2833	Penicillin	Butyl acetate and butyl alcohol	Solvent reclamation (done routinely)
2833	Alkaloids	Chlorinated solvents	Degreasing Reclamation
2865	Nitrobenzene	Benzene, nitrobenzene stripping	Paint Formulation Degreasing
2869	Ethyl chloride	Ethyl chloride, chloroethanes,	Paint remover solvents
2869	Epichlorohydrin	trichloroethylene, etc. — liquid still bottoms	Degreasing
2821	Methyl methacrylate	Hydroquinone; polymer heavy ends	Paper board binder
2869	Dicumyl peroxide	Organic peroxides	Paint industry-film formers

Source: Arthur D. Little, Inc.


Paterson-Clifton-Passaic
Allentown-Bethlehem-Easton
Newark
Jersey City
Pennsylvania
Trenton
PHILADELPHIA SMSA
New Jersey
Philadelphia
Camden
Chester
Wilmington
Scale (Miles)
0 10 20 30
Maryland
Delaware

Source: U.S. Department of Commerce, Bureau of the Census.

FIGURE C–1 PHILADELPHIA SMSA AND NEIGHBORING INDUSTRIAL AREAS

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TABLE C-2

RANGE OF PLANT EMPLOYMENT IN PENNSYLVANIA COUNTIES (BUCKS, CHESTER, DELAWARE, MONTGOMERY, & PHILADELPHIA) OF THE PHILADELPHA SMSA*

SIC No.	Industry	Number of Plants with Employees <20	20-99	100-499	>500
3691	Storage Batteries	1-2	1	1	1
3471	Electroplating	37	15	1	
3312	Iron & Steelmaking	5	4	3	8
332	Iron & Steel Foundries	3	8	3	1
3313	Primary Ferroalloys	1		1	
3331	Primary Copper			1	
333	Primary Non-Ferrous		1	1	
334	Secondary Non-Ferrous	10		4	
281	Inorganic Chemicals	30	24	15	2
2865	Organic Intermediates & Dyes	4	2		
2869	Industrial Organics, NEC	9	3	2	2
2831 & 2833	Pharmaceutical	16	1	1	
2879	Pesticides	7	8		1
285	Paints and Allied Products	17	13	6	1
2911	Petroleum Refining		4	1	6
3111	Leather Tanning	2	2	1	
355	Special Machinery	61	36	11	2
357	Office, Computing & Accounting Machines	16	11	9	4
Totals		220	133	62	28

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*The New Jersey counties (Burlington, Camden, and Gloucester) have less than 20% of the SMSA's industrial capacity, and were thus eliminated from discussion.

Source: U.S. Bureau of the Census, *County Business Patterns*, 1973; *Industrial Directory of the Commonwealth of Pennsylvania, 1972*, Harrisburg; Pa.: Department of Commerce & Industry, Commonwealth of Pennsylvania.

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TABLE C-3

SUMMARY OF WASTE GENERATION BY PLANT AND INDUSTRY IN THE PHILADELPHIA SMSA

		Potentially Recyclable Wastes		Recyclable-Wastes Available Per Plant		
SIC No. and Industry	Estimated Total Wastes, Phila. SMSA (MT/yr.)	Description	Quantity (MT/yr.)	No. of Employees	No. of Plants	Estimated Quan/Plant (MT/yr.)
3691–Storage Batteries	4,000	None				
285–Paints and Allied Products	4,800	Spoiled batches and waste solvents	2,100	< 20	17	6
				20- 99	13	40
				100-499	6	140
				> 500	1	670
2865–Cyclic Crudes and Intermediates	1,650	Still bottoms, tars, filter solids	1,650	< 20	4	125
				20- 99	2	570
				100-499	–	–
				> 500	–	–
2869–Other Organics	70,700	Still bottoms, tars, filter solids	70,700	< 20	9	140
				20- 99	3	1,200
				100-499	2	4,500
				> 500	2	28,000
2879–Pesticides	< 570	Unknown	Negligible			
2831 and 2833–Pharmaceuticals	1,030	Solvents, carbon filter acid, tars, and still bottoms	2,700	< 20	16	60
				20- 99	1	230
				100-499	1	1,500
				> 500	–	–
332–Iron and Steel Foundaries	100,600	None (wastes are slags, sludges, dusts, and sand)				
281–Inorganic Chemicals	109,000	None (wastes are primarily mixed metal sludges)				
3312–Iron and Steel Making	3,490,000	Pickle liquor	163,000	< 20	5	170
				20- 99	4	1,300
				100-499	3	6,100
				> 500	8	17,000
3471–Electroplating	2,000	Degreaser sludges (50% Cl & Fl_3 & 50% polishing compound)	60	< 20	37	0.7
				20- 99	15	2
				100-499	1	4
2911–Petroleum Refining	58,000	FCC catalyst, fines, coke fines, tank bottoms	6,800	< 20	–	
				20- 99	4	40
				100-499	1	400
				> 500	6	1,000
3111–Leather Tanning	2,900	Trimmings and shavings	170		5	35
355 and 357–Special Machinery	8,600	Metals, oil, solvents, acids, and alkalis	1,800	< 20	77	1
				20- 99	47	7
				100-499	20	40
				> 500	6	95

Source: Arthur D. Little, Inc., analysis of EPA industry studies.[3-48]

over 500 people. Well over 50% of the wastes, however, are estimated to come from the 28 largest plants. This is important to a materials exchange operator in analyzing the economics of his business. There is a lower limit to the quantity of waste which can be transferred economically. In the Philadelphia area, there are only few opportunities to transfer large wastes, and a materials exchange would face economic problems in dealing with large numbers of wastes in small volumes.

Despite the uncertainties in the data in Table C-3, they are the best available and provide a sufficient base for estimating the magnitude of the market for transfer services and the magnitude of the impact arising from the utilization of such services.

Identifying and Assessing Potential Opportunities

In order to test the potential transfer opportunities developed from publications and general experience, a number of managers of Philadelphia-area plants were interviewed. The first group was interviewed by telephone, as any transfer agent would do, to gather general information in a cost-effective way. The second group was visited personally, as a materials exchange operator would do, to describe the transfer concept in detail, gather specific information, establish rapport, and explore various transfer possibilities. Although most interviews did not lead to identification of immediate possibilities, the results of all are summarized below for the information of readers and as examples of data and assessments needed by transfer agents. These interviews provided data needed for this study to identify those wastes and industries best suited for transfer; interviews also provided insights needed to develop operational techniques for information clearinghouses and, especially, materials exchanges.

Telephone Survey of 35 Plants. Managers in representative industries were asked about (1) the accuracy of waste information for their plants as suggested by published literature, (2) their assessment of transfer possibilities listed in Table C-1, and (3) their reactions to the concept of using transfer agents.

Names and addresses were taken from the 1972 *Industrial Directory of the Commonwealth of Pennsylvania*, (20th ed.), but proved in some cases to be incorrect. In a few cases, the products manufactured differed from those typical of the SIC code assigned to the plant. In many cases, even though the product was identified correctly, their wastes differed drastically from those described in the literature. Thus, published data was only of limited value beyond getting started.

Results are summarized in Table C-4. The column "Wastes for Listing" shows the type of data which would be provided to an information clearinghouse. Experience, if any, with the use of secondary materials is recorded under "Wastes Used or Tried". The columns "Wastes Sold" lists, for the most part, materials which are not established by-products and which were at one time considered as trash wastes for disposal, but which are now routinely sold as scrap wastes. The column "Wastes Recycled" documents reuse of processing residuals within the plant. The column "Needed Materials" shows raw materials already used by the plant, and for which the column manager would consider a secondary materials source if available.

The information obtained through direct contacts with various plant managers differs substantially from that derived from the nationally-averaged data. The petroleum refining industry, for example, generates a spent caustic which was not included in the national data. This waste is occasionally transferred to paper mills. If a formal transfer service were available, higher percentages of this scrap waste would very probably find more steady markets.

The paint industry was assessed to be both a generator and a potential user of waste solvents. Many paint companies contacted in the Philadelphia area, however, produce only water-based paints.

Field Visits to 21 Plants. One purpose of these visits was to play, in part, the role of waste transfer agents, and to obtain first-hand information that would help to crystalize the scope of a possible waste clearinghouse. Results are summarized in Table C-5. As before the column "Wastes Used or Tried" lists those materials which have already been investigated by the manufacturer for inclusion into production; these materials may be used presently, or have been tried and discarded because of reasons noted in the table. "Wastes Sold" shows the by-products or scrap wastes presently sold to reprocessors, reclaimers, or other industries.

As might be expected, more detailed information was obtained in the plant visits than in the telephone interviews. The transfer concept was new to most plant managers, and many indicated that they had not really appreciated the value of the activity until discussed with them face-to-face. Although most managers were enthusiastic about the waste transfer concept, they reported many more offers to provide or sell wastes than requests to receive or buy them; this pattern is consistant with that seen by clearinghouses already in operation. But it should also be noted that the list of sold, recycled, and wanted materials is large; this suggests that more waste materials would be used if acceptable sources were known to manufacturers. It appears that many managers are alert to recycling opportunities and willing to try secondary materials, but are currently limited by lack of information.

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TABLE C-4
SUMMARY INFORMATION FROM TELEPHONE INTERVIEWS

	SIC No.	Product or Activity	Wastes for Listing	Wastes Used or Tried
1.	28	Specialty chemicals	None	None
2.	2865	Phenol	None	None
3.	3362	Brass and bronze	1. Dirty sand (12T/mo.); goes to landfill	None
4.	3312	Iron and steel, secondary	None	--
5.	2822	Urethanes	None	1. Reclaimed rubber 2. Foamed materials 3. Fillers
6.	2865	Aniline and nitrobenzene	--	--
7.	2819	Lithium chemicals	1. Undefined mud cake from filters (2 drums/wk)	--
8.	3312	Iron and steel	1. Electric furnace flue dusts, mixed iron oxides (60 tons/day); it is a fine powder which is now stored	1. 100% metal scrap utilized
9.	2822	Urethanes	None	--
10.	2843	Quaternary chlorides	None	--
11.	2843	Surfactants	1. Spent granular carbon (18,000 lb/yr); to landfill 2. Xylene, caustic, H_2SO_4, NaCl, fatty acids and alcohols stream 3. Methanol, free amines, TEA, DEA, fatty acids and alcohols stream 4. C_{11}-C_{14} fatty acid residues (50 lb/day)	None
12.	2911	Petroleum refining	1. Spent caustic, 8-10% NaOH and Na_2S (8000 bbl/mo.) 2. White water, 2% oil emulsion (4000 bbl/mo.) 3. Spent clay, Fuller's earth (15,000 yd^3/yr), contains 30-40% oil 4. Catalyst fines (3 tons/day); not rare metals, goes to landfill	None
13.	2816	Zinc Oxide	None	1. Various sources of zinc
14.	2911	Solvents and petrochemicals	1. Spent caustic 2. Spent acids 3. Oily sludges, dirt and oil accumulated in storage tanks 4. Biological sludges from water treatment	--

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TABLE C-4 (Continued)

Wastes Sold	Wastes Recycled	Materials Needed	Comments
--	None	--	Direct combination reactions. No wastes or by-products.
1. Acetone 2. α-Methylstyrene	1. High molecular weight organics mixtures used as fuel	1. Cumene, pure	Considers reuse whenever possible.
--	--	--	Recycles whenever appropriate.
--	1. Metal scrap	--	Recycling an economic necessity.
--	--	1. BOF dust 2. Crushed inorganics 3. Foamed materials	Compounded products produce no waste. Can use fillers for urethane.
--	--	--	Proprietary information not conveyed.
--	--	--	Recycles whenever appropriate. No appreciable waste generated.
--	--	--	--
--	--	--	Pure materials, e.g., isocyanates purchased from major producers. On rare occasions, company has a spoiled batch of urethane.
1. Unspecified by-products	--	--	Recycles whenever appropriate. Do use some scrap materials but information is proprietary.
--	1. Xylene 2. Fractionated raw materials	--	Has considered methanol recycling and use as fuel
1. Spent caustic on occasion to paper mill	--	--	White water is a stable emulsion and very difficult to break. Anxious to be rid of generated wastes for which they pay cost of disposal.
1. Zinc containing wastes to primary smelters when abundant	--	1. Sources of zinc	Recycles whenever appropriate.
1. Oily sludges sold to reclaimers 2. Spent caustic extracted to remove cresylic acids	1. Spent acids reprocessed outside plant and returned	--	Recycles whenever appropriate. Off-spec gasoline can be re-refined.

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C-4

TABLE C-4 (Continued)

	SIC No.	Product or Activity	Wastes for Listing	Wastes Used or Tried
15.	2834	Pharmaceuticals	1. Mold; now dumped 2. Carbon, steamed to remove solvent 3. Solvents 4. Mixed organics; hauled away	1. Reclaimed solvents
16.	3312	Iron and steel (fully integrated plant)	1. NH_3 liquor, very dilute (60 gal/min.) 2. Spent pickling liquor (9-10% $FeCl_2$, 1% HCl); now neutralized with lime and dumped 3. BOF dust, iron oxide with zinc content (50 tons/day); now dumped 4. KISH, magnetic iron oxide containing carbon, flaky and greasy; now dumped 5. Oil skimmings, hydraulic fluids (6000 gal/mo.); burned as fuel 6. Sludges from water treatment, high in FeO and oil 7. Crushed brick (10T/mo.); to landfill 8. Grease containing dirt (2 drums/mo.); to landfill	1. Limestone for flux; not usable
17.	3321	Iron and steel foundry	1. Slag (15-20 tons/week) 2. Residue from clean cutting of steel plate – magnetized (50T/yr)	--
18.	3297	Cement	1. Phosphate dust	--
19.	2851	Paint	1. Cleaning solvents – mostly water	--
20.	3271	Cinder block	--	Foundry slag (when available)
21.	2621	Bag paper and industrial tissue	None	1. Double lime Kraft waste 2. Cut stock waste
22.	3272	Concrete lintels	None	
23.	2621	Paper		
24.	2851	Latex paints	Dirty water	--
25.	2874	Fertilizer		1. Incinerator sludge from Chicago – used in nitrogen fertilizer manufacture 2. 72% waste sulfuric acid
26.	2851	Emulsion paints	1. Acrylic and vinyl emulsions	
27.	2851	Paint	1. Dirty water with pigments, latexes, and mercurials 2. Xylene and mineral spirits (80-100 drums/yr)	
28.	2621	Paper	1. Clarifier sludge (2-3T/day); 15% solids (fiber and clay filler); varying color	

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C-4

C-4

TABLE C-4 (Continued)

Wastes Sold	Wastes Recycled	Materials Needed	Comments
--	1. Methylene chloride 2. Isobutanol	1. Solvents 2. Fuels	Mixed organics are variable composition. Have considered reclaiming it. Some solvent burned as fuel.
1. Tar and low sulfur coke by-product (250,000 gal/mo.) – sold to a refiner for use as a roofing and road sealer			
1. Tar, low in sulfur (250 K gal/mo.); sold to refiner 2. BTX mixture, benzene, toluene, xylene; sold to distiller	1. Lime dust collected in mill	1. Lime	Mill is reluctant to use scrap materials. Small amounts of impurities have large effects on iron.
--		--	
--	--	--	
--	1. Industrial solvents (mineral spirits and alcohol) to a reclaimer	1. Extruders and fillers 2. Latex 3. Solvents 4. Pigments 5. Linseed oil	No use found for the waste in 100 years; too expensive to recover the phosphate for fertilizer.
--	--	1. Slag	
--	--	--	Use a hydropulper (no chemicals) in manufacture.
	1. Clarifier sludge – used in bleaching operation for Kraft paper 2. Bark – burned in boiler		Consider use of scrap materials too risky.
--	--		
		1. Pigments 2. Alkyd emulsions	
			No interest in scrap materials; concerned about color – must be pure white.
			Pays $2[illegible]/drum to have solvents hauled away.

C-5

TABLE C-5
SUMMARY INFORMATION FROM PLANT VISITS

	SIC No.	Product or Activity	Wastes for Listing	Wastes Used or Tried
1.	2879	Agricultural chemicals	1. 15-20% HCl, in limited quantity; being investigated for pickling 2. 90% acetone with some water, traces of CH_2O and HCl; difficult because of CH_2O, solvent reclaimers will not accept it; burned off 3. Treatment plant sludge containing small % of Cr, Zn, Ni, etc., as hydroxide precipitate; burned or landfill; exploring recovery	1. Ethylene dichloride, reprocessed; presented impurity problem 2. Heavy acids
2.	3321	Metal rolling	1. Spent pickling liquor, 10% HCl with 3% iron chloride (6000 gal/wk) 2. Caustic rinses, from cleaning operations 3. Water soluble oils, emulsifiable (66 gal/wk) 4. Electroplating waste, solid cyanide crystals plus salts, Na_2CO_3 (1500 lb/day)	--
3.	2834	Pharmaceuticals	1. Spent granular carbon, wet with water and solvent (600 lb/wk); has been used to decolorize solutions 2. Mold, wet (tons/day); decomposes rapidly; being looked at for feed; goes to landfill 3. HCl waste containing HCl, dibenzylamine, methanol (1000 gal/wk); presently neutralized with caustic and hauled away 4. Spent yeast, wet; goes to landfill (4 tons/yr)	--
4.	3069	Rubber	--	1. Reclaimed rubber
5.	2911	Petroleum refining	1. Waste water (oil, caustic, water) 2. API sludge; trucked out to land disposal 3. Spent H_2SO_4 4. Wash waters containing caustic, sulfides, phenols, solvents, oils, etc.	--
6.	3079	Cellophane	1. Cellophane, off-spec or waste, 8000 lbs/hr (or 1500 lb/day)	1. Fuel oils
7.	28	Diversified chemicals, metals, and consumer products	1. Greases from overruns; may be mixed types	--
8.	2821	Monomers	1. None	--

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C-5

TABLE C-5 (Continued)

Wastes Sold	Wastes Recycled	Materials Needed	Comments
--	1. Xylene, 90% recovered	1. HCl, H_2SO_4, HNO_3 concentrated and pure (no trace organics)	Expect to be reprocessing acids in future and reusing plant water. Raw materials are sensitive to impurities since they will affect chemical reactions.
1. 30% ferrous chloride; reclaimed from pickling liquor; cannot sell oil 2. Spent oils 5% (30 K gal/yr); given or sold to reclaimer	1. HCl; reclaimed from pickling liquor	1. Caustic; free of iron fines 2. Oils, lubricants, greases 3. NaOH 4. H_2SO_4	Waste oils have no fuel value at mill. Materials not sensitive to impurities but must be non-toxic and not reactive with metals.
1. Non-recoverable solvents (4000 gal/yr)	1. Solvents; some burned 2. Methylene chloride	1. Pure solvents	Materials must be very pure to meet FDA requirements. Everything is analyzed. However, traces of unknowns may not be found, which would present a potential hazard.
1. Carbon black – occasional contaminated lot	1. Carbon black; collected from dust collectors	1. Carbon black 2. Fuels	Material requirements limited. Energy requirements to generate steam are high. Fuel value materials would be important.
--	--	1. Concentrated H_2SO_4 2. Caustic	Oils, greases, hydrocarbons of reasonably known compositions from external or in-refinery sources can be reworked if necessary, and if available in large enough quantity to blend into refinery feedstocks.
1. Na_2SO_4; recovered by vacuum crystallization	1. H_2SO_4 2. Caustic 3. Glycerol/glycol plasticizers 4. Solvents 5. Carbon sorbents	1. Fuels (unsulfured) 2. Caustic (21-50%) 3. H_2SO_4 (>21%)	Detailed process information is proprietary. Little or no waste viscose generated. Emphasis is on reclaiming and recycling most materials in plant. H_2S is produced and is passed through the stack. Raw materials need to be pure since impurities will show up in cellophane. Do burn waste oils.
1. Spent cutting oils from machine operations 2. Spent HCl 3. Metal scrap	1. Cutting oils 2. Amalgam	1. Fresh cutting oils	Most operations in Philadelphia area are limited to machinery and fabrication operations. Chemical operations are "clean" or produce only very limited quantities of waste.
--	1. Solvents	1. Caustic	Aqueous waste streams are inconsistent. May contain a variety of acrylic acids and monomers, salts, solvent, by-product, catalyst and lacrymator. Total concentration is less than 5%, which makes recovery and separation impractical. No requirements for waste monomer or materials.

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B

C-5

TABLE C-5(Continued)

	SIC No.	Product or Activity	Wastes for Listing	Wastes Used or Tried
9.	2843	Specialty chemicals	1. Dirty wet oil (1.5 bbl/day); variable composition; hauled away 2. Water treatment sludge, 15% T.S. (5000 gal/mo.); hauled away 3. Sulfonated waste oils with iron fines and degradation products	1. Re-refined oils 2. Reclaimed mineral oils
10.	2843	Processing oils	1. Lime/$CaSO_4$ sludge, 30% water (15-20 tons/mo.); to landfill	--
11.	3674	Electronic devices	1. Mixed solvents (50-100 gal/mo.)	--
12.	3312	Iron and steel	1. Electric furnace dust; contains Fe, Zn, trace elements; being investigated as a soil additive 2. BOF dust; a fine iron oxide containing FeO, MgO, ZnO, Al, P, S, Si (90 tons/day); cannot be reused because of Zn content which affects blast furnace refractories	1. 90-95% C from rubber plant flue dust; pelletized for coke; contained too much sulfur 2. Limestone, 90-95% $CaCO_3$, $MgCO_3$; too fine for ease of use 3. Chlorinated hydrocarbons; burned as fuel and the scrubbed HCl is used for pickling
13.	3471	Electroplating and anodizing	1. 15% H_2SO_4 anodizing bath with aluminum 2. Soap cleaners with oils, waxes and polishing compounds 3. NaOH etchant pH 13; with sodium aluminate 4. Contaminated aluminum hydroxide precipitates	--
14.	3479	Lacquers	1. Polymeric sludge	--
15.	3330	Copper smelting		1. Copper bearing sand is primary raw material
16.	2851	Paints	--	1. Off-spec latex 2. Surplus cans
17.	2843	Soaps and surface treatment compounds	1. Spent lye 2. Dilute sulfuric acid	1. Fats and tallows – purchased from a broker 2. Various surplus chemicals

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C-5

TABLE C-5 (Continued)

Wastes Sold	Wastes Recycled	Materials Needed	Comments
1. Waste oils (15,000 gal/yr); to oil reclaimer		1. 91% H_2SO_4 for water treatment 2. Mineral oils and other types of oils	Would have little to offer an exchange, but could use oil and wax materials if not contaminated or toxic.
--	--	1. 98% H_2SO_4 2. Oils, waxes, fats, etc. 3. Solvents	Raw materials need not be pure and in some cases can be mixtures. Oils and fats can be water nonsoluble as long as they can be converted to emulsifiable forms.
1. Collected precious metal scrap (100 lb/mo.), sludge, floor scraping, etc.; to refiner	1. Precious metal pastes	--	Materials extremely sensitive to impurities. Cannot tolerate impurities since they will affect electrical characteristics.
1. HCl pickling liquor; sold to broker 2. Blast furnace slag; used for paving aggregate or concrete blocks	1. Iron and steel scrap 2. Blast furnace slag reused as flux	1. Sources of iron 2. Carbon 3. Lime 4. Fuels 5. Chlorinated hydrocarbons to generate HCl 6. HCl for pickling	
1. Chrome plating tank residue – incidental; to a competitor 2. Oil Tank Bottoms – to reclaimer	--	1. Nickel sulfonate	
--	1. Solvent blend (mostly MEK) with lacquers and enamels – 1 drum/day – to reclaimer	--	
1. Blast furnace slag – marketed for sand blasting	1. Fine slag from black copper refiner and filter bag dust is recycled to the blast furnace	--	
--	--	--	Small company that deals in off-spec and slightly contaminated chemicals as a sideline.
--	--	1. Fatty acids 2. 40% caustic 3. Mineral oils 4. Paraffin waxes 5. IPA 6. Glycols 7. Ethanolamines	Sells to the textile industry, which might sue if a finishing agent affected fiber properties adversely.

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C-5

TABLE C-5 (Continued)

	SIC No.	Product or Activity	Wastes for Listing	Wastes Used or Tried
18.	28	Carbon black dispersions, surfactants and polymers (sodium polyacrylate)	1. Dilute ammonia 2. 20% methanol	1. Surplus stock for dealers
19.	2295	Rubber and plastic coated cloth	1. Resin bottoms (coating mixtures left in cans) 2. Scrap – burned in boiler before converting to oil	1. Reclaimed rubber
20.	2843	Fabric finishing agents	1. Surfactant blends which accidentally freeze on shipment 2. Off-spec batches	1. Surplus stock for dealers
21.	2834	Pharmaceuticals	--	--

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C-5

TABLE C-5 (Continued)

Wastes Sold	Wastes Recycled	Materials Needed	Comments
—	—	1. Peroxide catalysts 2. Caustic for cleaning tanks	Continuity of supply is very important. Surplus or waste must be available in the quantity needed for 12 months.
—	—	—	Would not risk the use of scrap chemicals, which might ruin a customer's cloth.
1. Surplus stock – to brokers	—		
—	1. Solvents	1. Sodium hypochlorite 2. Sodium hydroxide Both for water treatment	Cannot ever accept solvent wastes for cycling through their recovery facility, because of strict FDA requirements.

APPENDIX D

ECONOMICS OF TRANSFERRING WASTE MATERIALS

This Appendix presents details of the economic analysis of transferring scrap wastes. The first section discusses the basic analysis of transfer between generator and user directly, without the assistance of a transfer agent. The second section applies this basic analysis to identify the business opportunities and limits of a materials exchange, which derives its income from the transfers it arranges as middleman between generator and user.

ECONOMIC FEASIBILITY OF A TRANSFER

Costs of the Transfer and No-Transfer Options

The economic effect of a transfer can be determined by comparing the costs incurred by generator and user with those which would be incurred if no transfer takes place. Suppose that generator's W pounds of scrap waste would be acceptable to user in place of R pounds of raw material purchased elsewhere. Under the first or no-transfer option, generator arranges for disposal of its waste at a cost of C_D cents per pound, while user independently purchases its raw material from a supplier at a cost of C_{RM} cents per pound; the total cost of this no-transfer option is thus:

$$C_1 = WC_D + RC_{RM} \text{ (¢)} \qquad (1)$$

Under the second option, if the transfer can be made, the costs are quite different. Generator is no longer liable for disposal costs and user need not buy raw material. However, two other costs become necessary:

- Transportation costs, to move the waste from generator's plant to user's plant; if these plants are M miles apart and the unit transport cost is C_T cents per lb-mile, transport cost is WC_TM (¢).

- Transfer costs including administrative costs for arranging the transfer, handling costs (if any), and costs of processing the waste to meet user's requirements. Transfer cost may be zero, if no handling (other than direct transport between plants) or processing are required. The magnitude of the administrative costs attributable to the transfer depend on the nature of the waste material, how the transfer is arranged, and the total number of transfers over which these costs can be spread. The net transfer cost, C_A, is expressed in cents per pound of waste transferred.

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TABLE D-1

DEFINITIONS AND UNITS FOR ECONOMIC ANALYSIS

Term	Definition	Unit of Measure
B	Net economic benefit or gain from a transfer	cents (¢)
b	Net benefit or gain per unit of scrap waste	cents per pound (¢/lb)
C_1	Cost of no-transfer option, when generator pays to dispose of the scrap waste and potential user pays to buy raw material from other source	cents (¢)
C_2	Cost of transfer option, when generator need not pay disposal cost and user need not buy raw material	cents (¢)
C_A	Net cost of administering the transfer, including such costs as communications, advertising, managerial time, handling charges, and processing the waste to meet requirements of the user.	cents per pound (¢/lb)
C_D	Cost of disposal of the waste	cents per pound (¢/lb)
C_{RM}	Cost of the raw material for which the scrap waste might substitute	cents per pound (¢/lb)
C_R	Cost of the scrap waste *as* raw material for the user's process	cents per pound
C_T	Cost of transporting the scrap waste from generator to user	cents per pound per mile (¢/lb/mi)
f_D	Fraction of the disposal cost paid by generator if the scrap waste is transferred	cents per pound (¢/lb)
f_R	Fraction of the raw material cost paid by user if he accepts the scrap waste as a substitute	cents per pound (¢/lb)
M	Distance between generator and user	miles (mi.)
N	Number of transfers completed annually	number
W	Scrap waste available for transfer	pounds
X	Net annual income of materials exchange from all transfers	dollars
y	Unit income or revenue earned by arranging a transfer	cents per pound
Y	Income earned by arranging a transfer	dollars ($)

The total cost of the transfer option is thus:

$$C_2 = WC_TM + WC_A \ (¢) \tag{2}$$

The Economic Effect Model

The transfer will produce a net economic *benefit* if costs associated with the transfer option, Equation (2), are less than costs associated with the no-transfer option, Equation (1). Conversely, the transfer will lead to a net economic *loss* if C_1 is smaller than C_2.

The net benefit (B) of a transfer can be expressed mathematically as

$$B = C_1 - C_2$$

or

$$B = WC_D + RC_{RM} - WC_TM - WC_A. \ (¢) \tag{3}$$

The benefit per unit of scrap waste is

$$b = B/W = C_D + \frac{R}{W} C_{RM} - C_TM - C_A \ (¢/lb)$$

The term ($R/W \ C_{RM}$) is the unit value of the waste as raw material, taking into account the fact that the waste may have more or less (almost always less) of the important raw material than that substance purchased from a regular supplier. The ratio of amounts (R/W) is given here simply to demonstrate that scrap wastes normally will not replace raw materials on a pound-for-pound basis, and that the amount of waste which is "equivalent" to one pound of raw material influences the economics of the transfer. Having made that point, let us replace the term ($R/W \ C_{RM}$), the value of waste as raw material, with the single term C_R.

The benefit equation then becomes

$$b = C_D + C_R - C_TM - C_A. \tag{4}$$

This simply shows that if the transfer is to show a net benefit, the generator's cost of waste disposal (C_D) plus the user's cost of an equivalent amount of raw material (C_R) must exceed the sum of the costs of transportation (C_TM) and of administering the transfer (C_A).

Implications of the Model

It is difficult to evaluate the economics of specific transfer opportunities without first knowing the transfer cost (C_A); this can be known only by analyzing the economics of the materials exchange itself, including the number of transfers which it arranges during the year, as shown below. But the result of that analysis shows that a reasonable transfer cost is one-half cent per pound. The cost of transporting the waste is about 0.005 cents per pound-mile.* Therefore, the net benefit is (from Equation (4))

$$b = C_D + C_R - (0.005)\,M - 0.5.$$

Whether a specific transfer shows a net positive benefit depends on the waste disposal cost foregone (C_D), the cost of raw materials replaced (C_R when expressed in terms of waste quantity), and the distance the waste must be shipped. If generator and user are 50 miles apart, then

$$\begin{aligned} b &= C_D + C_R - (0.005)\,(50) - 0.50 \\ &= C_D + C_R - 0.25 - 0.50 \\ &= C_D + C_R - 0.75 \end{aligned}$$

and the benefit will be positive if $C_D + C_R$ is more than 0.75 cents per pound.

Alternatively, if $C_D + C_R$ is 2 cents per pound, then

$$\begin{aligned} b &= 2.0 - 0.005M - 0.50 \\ &= 1.5 - 0.005M \end{aligned}$$

and the benefit will be positive if the distance (M) between plants is less than 300 miles.

The foregoing analysis deals only with the *overall* economics of the transfer, i.e., how much the net cost of the transfer exceeds or is less than the comparable costs of the no-transfer option. The analysis says nothing about how this benefit is allocated among the three parties-at-interest (namely, the generator, the user, and the materials exchange). This allocation is important since each of these economic actors is more concerned about its own gain or loss than about the overall benefit.

The economics of the materials exchange, discussed below, depend on a number of factors, mainly how many transfers it can arrange in a year. However, generator and user react to individual transfer opportunities, and this economic analysis of a single transfer can help to identify when a transfer will appear economically attractive to both.

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*This is an average cost, based on tank-truck loads. Specific cost quotes can be obtained from local contract haulers.

By participating in a transfer of scrap waste, both generator and user incur risks which would not exist if each acted separately to dispose of waste and purchase raw materials. Generator incurs the risk that his waste material, when used by someone else as a raw material, will cause (or be thought to have caused) a problem for which generator may be held liable. User runs the risk that the waste will contain some impurity which, when used as raw material, will degrade his product or damage his process equipment. Neither generator nor user will accept these risks unless he sees some offsetting advantage, most likely to be economic gain.

The comparative cost of the transfer and no-transfer options to each transfer partner can be expressed in the terms of the overall economic analysis. The cost of the no-transfer option to the generator is C_D, his cost of disposal of the waste. Suppose, if the waste is transferred, that he pays only a fraction of his normal disposal cost (f_D), a fraction determined by negotiation between generator and user. The difference in costs ($C_D - f_D C_D$) becomes the profit which compensates him for the risk he incurs in transferring his waste. Similarly, the user might only be required to pay for the scrap waste only a negotiated fraction of its value (f_R) as raw material equivalent. His saving over the no-transfer option is ($C_R - f_R C_R$), compensating him for the risk which he incurs.

The benefits of the transfer depend not only on unit savings per pound, but also on the total amount of the material. If T tons are transferred, the savings become:

For the generator: $$C_D(1 - f_D)\,T\left(\frac{2000}{100}\right) \quad (\$) \qquad (5)$$

For the user: $$C_R(1 - f_R)\,T\left(\frac{2000}{100}\right) \quad (\$) \qquad (6)$$

These expressions can be plotted for easy reference (Figure D-1). Here the value of the scrap waste to the generator (C_D) or the user (C_R) is plotted against the amount (T) to be transferred. The lines sloping across the logarithmic graph show the dollar savings accruing to generator or user.

For example, suppose a chemical maker can use 100 tons of scrap waste to replace a raw material whose comparable cost is 5¢ per pound. Assuming that he pays only 70 percent of the raw material value ($f_R = 0.70$), user's profit (or saving) would be:

$$(5)\quad(1 - 0.70)\quad(100)\left(\frac{2000}{100}\right) = \$3000.$$

1-5

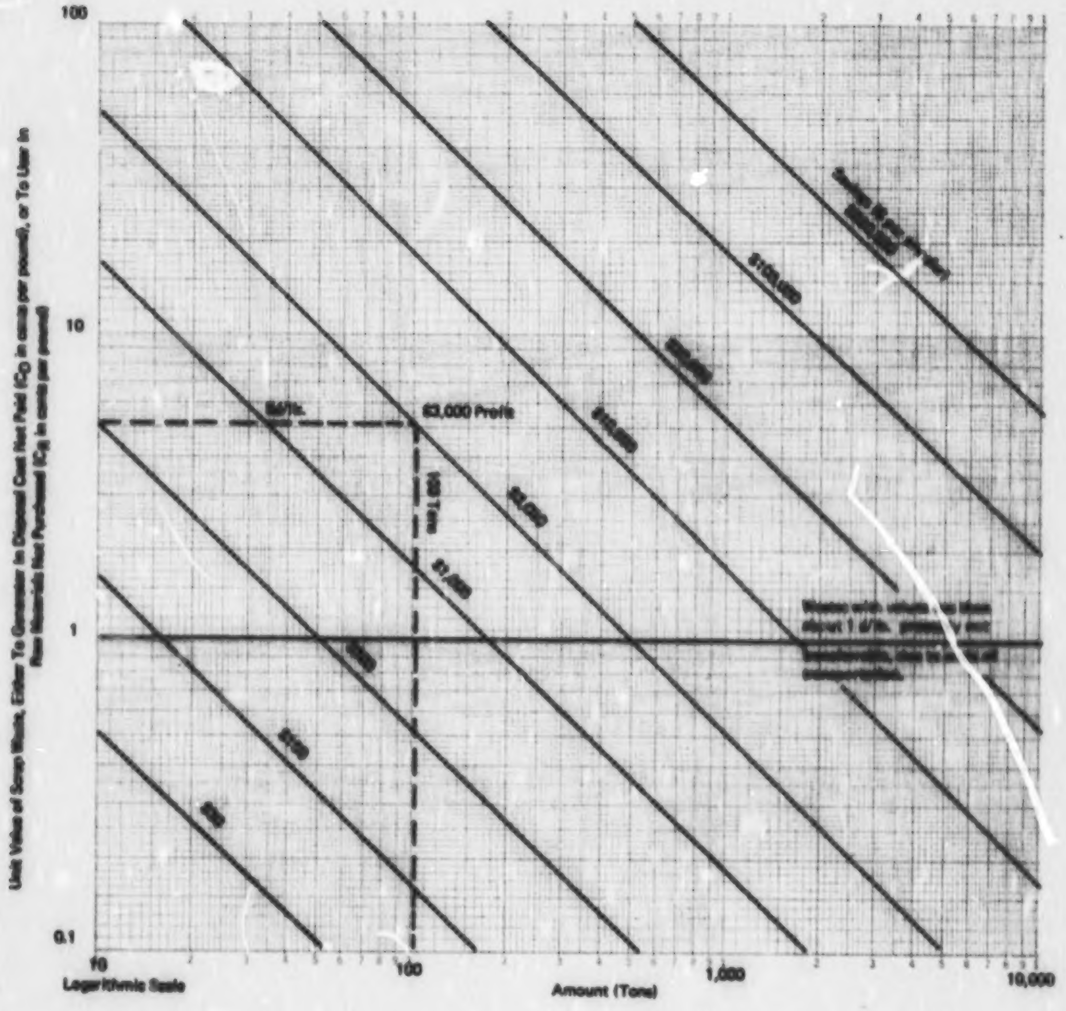

FIGURE D–1 SAVINGS TO GENERATOR WHEN DISPOSAL COST REDUCED 30% OR TO USER WHEN RAW MATERIAL COST REDUCED 30%

Likewise, suppose that a generator can transfer 100 tons of his waste instead of paying for its disposal at 5¢ per pound. Assuming that generator must pay (for costs of transportation and transfer) only 70 percent of his normal disposal cost ($f_D = 0.70$), his profit (or saving) would be:

$$(5) \quad (1 - 0.70) \quad (100) \left(\frac{2000}{100} \right) = \$3{,}000.$$

This value can be located in Figure D-1 by finding the intersection of the horizontal line associated with a value of 5¢ per pound with the vertical line associated with an amount of 100 tons. These lines intersect at the $3,000 profit sloped line.

Note that Figure D-1 applies only for the assumed 0.70 fractions of disposal cost (f_D) paid by generator and raw material cost (f_R) paid by user. For other values of the fractions, the savings lines would shift vertically. For example, if $f_D = 0.6$, the lines would shift down by the fraction $\frac{1 - 0.7}{1 - 0.6} = \frac{0.3}{0.4}$, and the profit would be $4,000; if $f_D = 0.85$, profit would be $1,500. For the general case, however, use Equation 5 for generator and Equation 6 for user to evaluate savings in a potential transfer.

No matter how the profit picture looks to the generator or user, the transfer will not take place if the amounts they pay do not cover transportation and transfer costs The amount available to cover these costs is $f_D C_D + f_R C_R$; in our example, where $f_D = f_R = 0.70$, it is 0.7 ($C_D + C_R$). The transfer costs were estimated at 0.5 cents per pound and transport costs for a 50-mile transfer were 0.25 cents per pound. Therefore, payments by generator and user will cover transportation and transfer costs almost exactly if

$$C_D + C_R = \frac{0.75}{0.7} = 1 \quad (¢/\text{lb})$$

Figure D-1 shows a horizontal line at this value of 1 ¢ per pound as a reminder that transfer of material with sufficiently low value is not economic *overall*. The position of this line is somewhat arbitrary, since it depends on the *sum* of both disposal and raw material costs, whereas the graph's vertical axis shows the unit value of scrap waste either to generator or to user but not to both. The line could be drawn at a value of 0.5¢ per pound if the disposal cost (C_D) and the value as raw material (C_R) were equal. The purpose of this line is merely to indicate the approximate value below which transfer is not likely to be feasible, due to transportation cost.

Parameters of the Model

This economic model shows that the gains or benefits which may result from a potential transfer will be influenced by several factors. One is the distance between generator and user; the greater the distance, the less likely the overall economic benefits. Another is the transfer costs. Administrative costs, whether incurred by generator and user themselves or by a materials exchange, must be covered. Processing costs can be significant; if, for example some impurity must be removed before the waste is acceptable by the user, costs may run as high as 3 cents per pound, or even more, as is apparent from industry studies.[8-10] Processing costs would be incurred by whomever removes the impurities, whether generator, user, or a scrap reclaimer, but would be paid ultimately by the trading partners benefiting from the transfer, namely generator and user.

The model also shows how these several costs influence the overall economic benefit. Equation 4 makes apparent that an increase in the transfer cost, for example of 3 cents per pound for processing the scrap waste, would require, if a constant economic gain is to be maintained, that the value of the waste ($C_D + C_R$) be greater by an equal amount.

Finally, the fraction of value paid by the user and the fraction of disposal cost paid by the generator determine how much is available to cover transportation and transfer costs. The higher these fractions, the more attractive the overall economic benefit, because more money is made available to pay for these transport and administrative costs. Note, however, that increase in these fractions also reduce the economic incentives to generator and user to seek help from a third-party, the materials exchange, and increase their incentives to arrange the transfer directly and thus to avoid paying the transfer agent's charges.

ECONOMICS OF TRANSFER BY A MATERIALS EXCHANGE

Income Earned by Completing Transfers

As the middleman between generator and user, the materials exchange must earn its income from the transfers which it arranges. The analysis above showed that the net economic benefit per unit of waste transferred, is:

$$b = C_D + C_R - C_T M - C_A \quad (¢/lb) \tag{4}$$

However, generator will pay only a fraction of his normal disposal cost foregone (f_D) in compensation for his risks in the transfer, such as liablity. Similarly, user will pay only a fraction of his normal raw material cost foregone (f_R) to compensate for the risks he runs, such as unexpected impurities in the scrap waste. Therefore, generator retains $(1 - f_D) C_D$ and user retains $(1 - f_R) C_R$. If $f_D = f_R = f$, the first two terms on the right side of Equation 4 can thus become $f(C_D + C_R)$. As the transfer agent, the materials exchange bears the transfer cost (C_A). Moving C_A to the left-hand side of Equation 4, the sum of C_A and b becomes the income y received by the exchange per unit of waste transferred. Making these two adjustments, Equation (4) becomes:

$$y = b + C_A = f(C_D + C_R) - C_T M \ (¢/lb) \qquad (7)$$

Using $f = 0.7$, $C_T = 0.005$ cents per pound-mile, and $M = 50$ miles, and changing the units of y from cents per pound to dollars per ton by the factor (2000/100), yields:

$$y = \left[0.7\left(C_D + C_R\right) - 0.25\right]\left(\frac{2000}{100}\right) \ (\$/ton) \qquad (8)$$

The income earned from a transfer, Y, is obtained by multiplying Equation (8) by the tonnage (T) of waste transferred:

$$Y = yT = \left[0.7\left(C_D + C_R\right) - 0.25\right](20)T \ (\$)$$

or

$$Y = \left[14\left(C_D + C_R\right) - 5\right]T \ (\$)$$

The net annual income to the exchange, X, is simply the sum of the Y's from all of the transfers arranged during the year.

$$X = \sum_{i=1}^{N} Y_i \ (\$) \qquad (9)$$

where N is the number of transfers during the year. This value of X must equal or exceed the administrative costs of the exchange, which is estimated (Chapter VIII) to fall within the range $50,000-$150,000; assume for illustration $90,000. Therefore:

$$90{,}000 = \sum_{i=1}^{N} Y_i$$

Transfers Required to Break Even

Now, Y will vary from transfer to transfer, because both of the major determining components (value and tonnage) will vary. However, if all of the transfers occurring in one year had the same average value ($C_D + C_R$) and the same average tonnage T, the above equations could be combined to give:

$$90{,}000 = NY$$

$$N\left[14\,(C_D + C_R) - 5.00\right]T \qquad (10)$$

and we could solve for N, the number of transfers necessary to cover the exchange's administrative costs. This value, denoted N_O, is:

$$N_O = \frac{90{,}000}{\left[14\left(C_D + C_R\right) - 5.00\right]T} \qquad (11)$$

The break-even value N_O depends on value of the material and tonnage transferred, and decreases as either or both of these factors increases.

Equation 11 can be plotted on a graph (Figure D-2). Data about the values and tonnages of materials which might be transferred will locate points on the lines denoting the numbers of transfers required annually for the exchange to break even. For example, consider a scrap waste material with value of 0.9¢/lb. and being offered in lots of 1,000 tons. First, enter Figure D-2 on its horizontal axis at value 0.9¢/lb.; then, follow the 0.9¢/lb. line up to its intersection with the curve for 1,000 tons; finally, follow the horizontal line through that intersection left to the vertical axis at 12, which shows that 12 such transfers would be required annually to cover the exchange's administrative costs.

The graph shows that the number of transfers required increases sharply with decreasing tonnage and decreasing value. In fact, if the waste values are less than 0.36¢/lb, the exchange cannot break even no matter how many transfers are arranged, because of the cost of transportation when generator and user are assumed to be 50 miles apart.

Potential Opportunities

A materials exchange operator, by using this graph, can assess whether a materials exchange would be viable by plotting points representing potential waste transfers or actual wastes offered for transfer. For example, Figure D-3 shows waste offers published recently by the United Kingdom and the St. Louis clearinghouses. Waste tonnages were published, but we computed their values by factoring current prices for virgin materials down to the published concentrations. No penalty for possible impurities was exacted. Disposal costs (which would accrue in the absence of transfer) were assumed to be zero. These assumptions tend to offset each other, but the real net effect on value could not be computed with the information available.

Transfer of the offered caustic soda alone (at 42,000 tons and a factored value of 1.85¢/lb) would more than finance the exchange's operations for a year; so would the

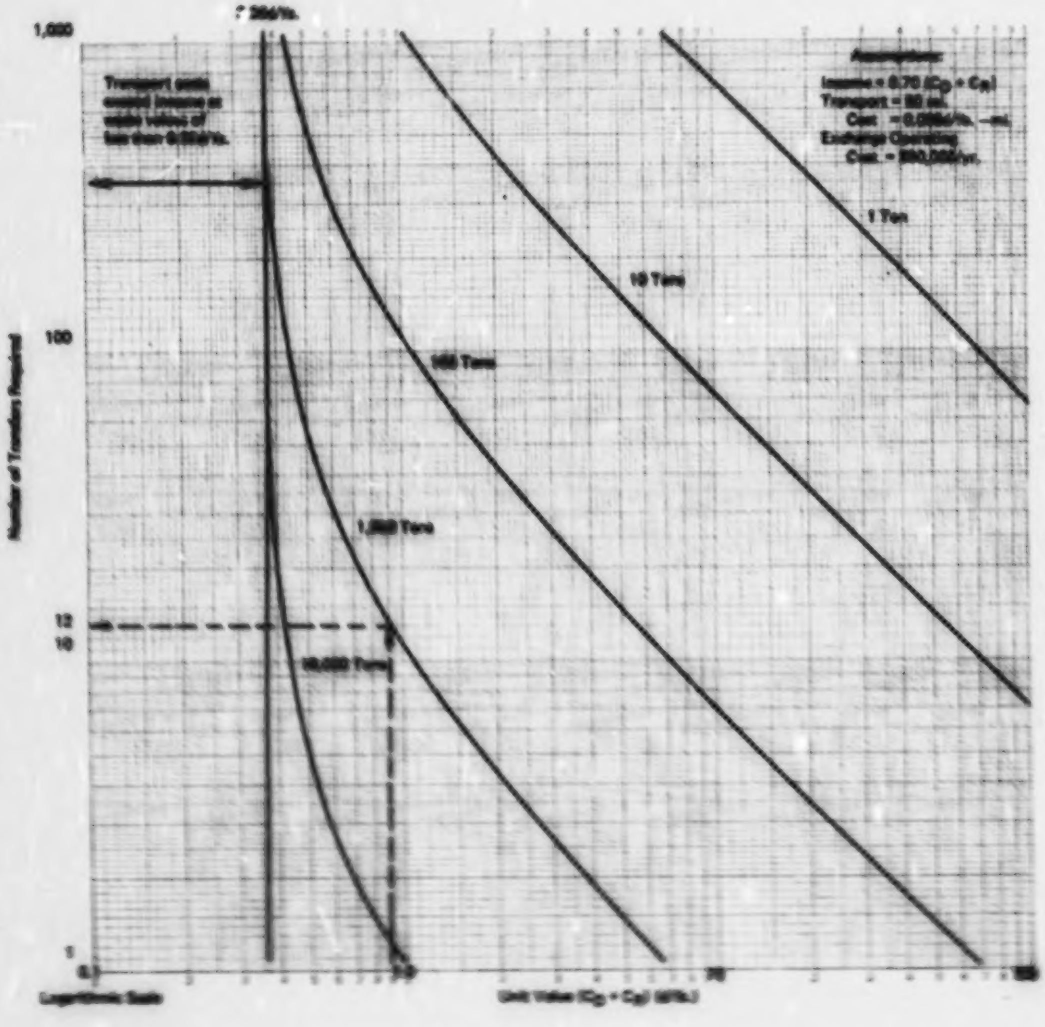

FIGURE D–2 ECONOMICS OF A MATERIALS EXCHANGE

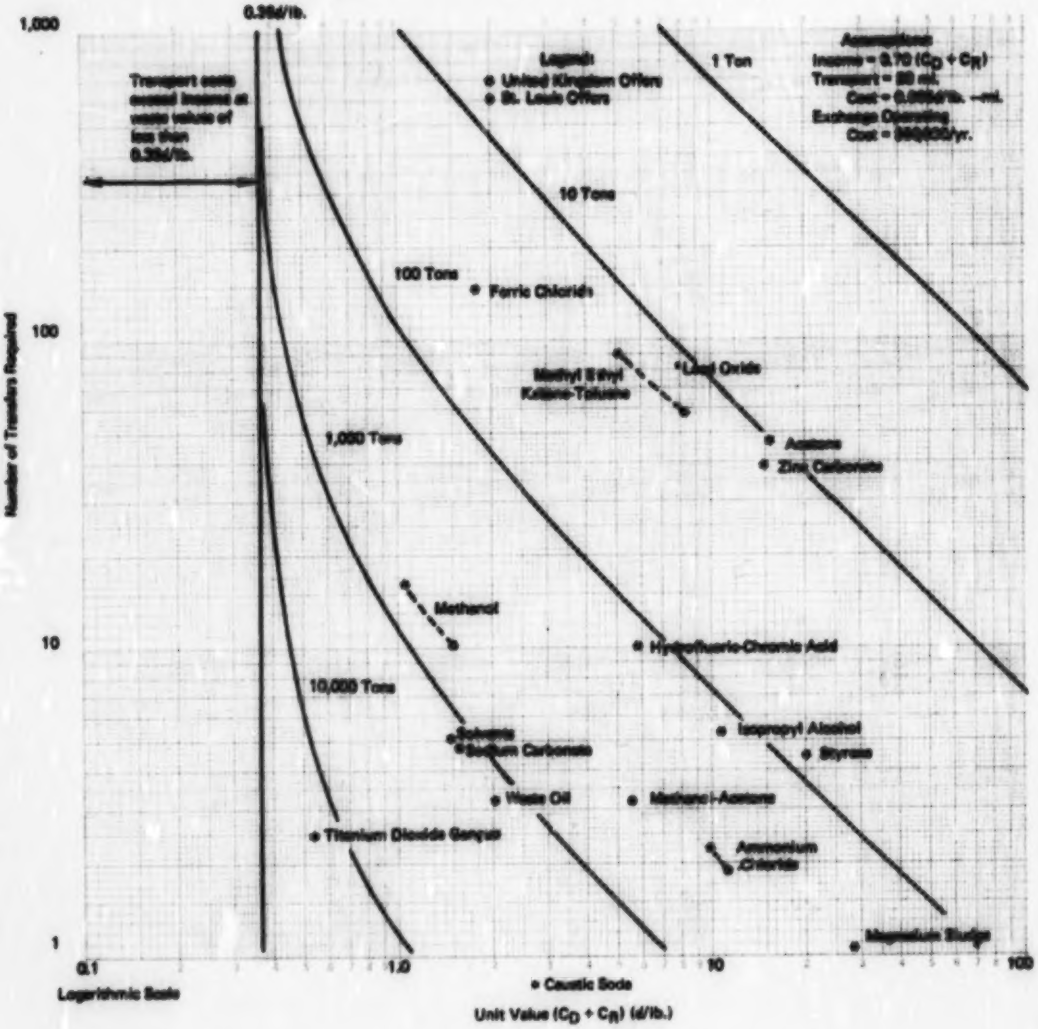

FIGURE D–3 ECONOMICS OF TRANSFERRING SELECTED WASTES magnesium sludge (at 400 tons and 30¢/lb). Other attractive offerings were ammonium chloride (at 440 tons and 10¢/lb) and a methanol-acetone mixture (at 610 tons and 5.3¢/lb). Each of these alone would nearly finance operations for one year. The metals, lead oxide and zinc carbonate, would earn less profit despite high values, because of their low tonnages (11 and 14 respectively); between 40 and 70 of such transfers would be required each year.

Some offerings of large amounts of low-value wastes, principally spent and diluted sulfuric and hydrochloric acids, do not fit well on the graph and thus deserve special discussion. Specific offerings from sample lists include:

Waste Offers	Tonnage (tons/yr.)	Value of Waste as Raw Material (¢/lb)
Sulfuric acid	1,400	0.2
Hydrochloric acid	2,100	0.25
Sulfuric acid	165,000	0.5

Because the first two acid wastes are valued significantly below the assumed transportation cost of 0.36¢/lb, they could not be transported even 50 miles at a profit. The third offer is interesting because its value is slightly more than the 0.36¢/lb transport cost, and because its tonnage is very large. If these cost values held, the income to the exchange for arranging a transfer of this waste would be:

$$(165{,}000)\left(\frac{2000}{100}\right)(0.50 - 0.36) = \$462{,}000$$

which would more than meet the exchange's estimated annual operating cost of $90,000. However, if the perceived value to the user were a little less and/or if the transportation costs a little more, the potentially large profit could turn into an equally large loss. Moreover, it would be very difficult to find one or more users for this amount of waste acid within a reasonable distance from the generator. Thus, the exchange should not expect to finance itself on this type of transfer, regardless of how attractive the economics might appear in theory.

The foregoing analysis and our assessment of potential opportunities presented in Chapter III shows that a materials exchange which tries to derive its income solely from transfers actually completed will experience continuing difficulty in paying its operating expenses, even in a densely industrialized area such as the Philadelphia SMSA. Some scrap wastes with attractive revenue potential are more likely to be transferred directly between generators and users than by means of the exchange. It is doubtful that enough lower-volume, lower-value wastes can be transferred to pay for the exchange's operating expenses.

APPENDIX E

INSTITUTIONAL ANALYSIS AND OPTIONS

Before any scrap waste can be transferred, the many requirements—technical, economic, marketing, and legal—must be satisfied for both generator and user. However, the tasks of satisfying them can be distributed among various participants in the transfer system. The simplest and most ideal case exists when generator and user are the same plant; such transfers can be almost costless. Next best is when negotiations are carried out between two plants or companies directly; in both cases, all requirements are satisfied by the transfer partners themselves. At the next stage, when generator or user cannot satisfy all of its own needs, the transfer agent steps in to help. In turn, the transfer agent does not operate independently, but is influenced by various marketing and institutional factors.

INFLUENCES ON TRANSFER AGENTS

The transfer of a scrap waste is a complex transaction, fraught with uncertainties and risks. The role of a transfer agent is therefore also complex. The many factors influencing how a transfer agent might organize itself are noted in the following tables, designed to help potential managers and sponsors of transfer services. By considering where their own circumstances fall along the ranges of options, they can develop a profile of likely characteristics of their organization. These tables were used in developing the comparison between information clearinghouse and materials exchange (Table IV-1).

It is useful to consider the factors in two groups. The first includes characteristics of the transfer agent itself; these are internal factors which are within the power of its sponsors and managers to choose and control (Table E-1). The second group includes characteristics of the organization's technical, business, and legal environment; these are external factors which, once its managers have chosen its geographic location, are largely beyond their power to control (Table E-2).

INSTITUTIONAL SPONSORSHIP

Several types of institutions might sponsor an information clearinghouse or a materials exchange. In theory, a transfer organization could be independent; but in practice, such requirements as credibility with industry, technical resources, and economic backing produce the need for some form of institutional or financial sponsorship. In fact, the sponsor is the most important institution in the business environment of a clearinghouse or exchange, especially in their initial states.

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TABLE E-1

INTERNAL CHARACTERISTICS OF WASTE TRANSFER ORGANIZATIONS

Descriptor	Spectrum					
1. Services Offered	By magazine ads		By special clearinghouse	Only handling and transport		Analysis, reprocessing, and transport
2. Service Role or Strategy	Passive					Active
3. Geographic Radius Served Normally	25 mi.	50 mi.	75 mi.	100 mi.	1,000 mi.	2,000 mi.
4. Industry Coverage Offered	1 sector of an industry		1 Industry	Related Industries		Many Industries
5. Type of Clients Sought	Small, local firms; weak technical skills			Medium, regional; moderate skills		Large, national firms; strong technical skills
6. Number and Value Scrap Wastes Accepted	Few, most valuable only					Many, even of marginal value
7. Volume of Activity	Small, episodic, unpredictable			Moderate, variable		Large, continual, regular
8. Legal Status	Private Individual	Non-Profit Institution	Private Firm	Private Firm with Government Franchise	Special-Purpose Government Corporation	Government Line Agency
9. Private-Sector Organizational Forms	Private Individual	Informal Network	Trade Association	Independent, small, single company		Subsidiary of large multi-purpose company
10. Public-Sector Sponsors	Single local Government	Several local governments	State agency	Multistate authority	Federal agency	International federation

TABLE E-1 (Continued)

INTERNAL CHARACTERISTICS OF WASTE TRANSFER ORGANIZATIONS

Descriptor	Spectrum						
11. Skills of Staff	Limited (managerial and clerical)		Moderate (arranging) contracts)		Extensive (chemical analysis, processing, marketing)		
12. Technical Experience and Imagination of Staff	Limited		Moderate			Extensive	
13. Size of Professional Staff	1 part-time manager, few volunteer advisors		1-3 full-time			3-6 full-time	
14. Data Bank	Blackboard, simple card files		Files, library, staff experience, and contacts Limited	Moderate	Extensive	Large, Computerized, matching + retrieval system	
15. Advertising	Informal word-of-mouth	Via magazine and journals	Special lists	Occasional marketing		Vigorous marketing	
16. Pricing Policy	Free		At cost			At profit	
17. Financial Policy	Subsidized informally	Subsidized formally	Subsidies and revenues	Break even on revenues		Profit or surplus	
18. Income Sources	Individual subsidies	Informal subsidies	Formal subsidies	Client Fees (Waste Users)	Client Fees (Waste Generators)	Partial public subsidies	Full public subsidies
19. Risk level acceptable	None	Small		Medium		Large	
20. Style of Management	Reactive			Mixed		Entrepreneurial, aggressive	
21. Capital Requirements	0			$100,000		$350,000	
22. Annual Operating Budget (all costs accounted)	$10,000					$150,000	

TABLE 5-3

EXTERNAL CONDITIONS INFLUENCING TRANSFER ORGANIZATIONS

Descriptor	Hindrance	←	Spectrum	→	Aid
1. Industrial locations	Dispersed				Concentrated
2. Transport costs	High				Low
3. Number of small, low technology firms	Few				Many
4. Disposal costs to generators	Low and Stable				High or Rising
5. Competing raw materials costs to users					
6. Treatment Costs	High				Low
7. Industry Communications	Extensive, inter-industry				Little or none, within industry
8. Generators' Analysis and Knowledge of Waste Stream Chemistry	Much				Little or none
9. Users' Technical Knowledge					
10. Potential Value of Scrap Wastes	Low				High
11. Concentration of Scrap in Waste Stream	Low				High
12. Regularity of Streams (combined total)	Episodic				Sustained, continuous
13. Quantity of Wastes Available for Transfer	Small				Large
14. Public Awareness of Environmental Dangers	Low				High
15. Initiative Available to Create Transfer Organization	Individual, Voluntary	Informal, Group, Voluntary	Formal, Group, Voluntary	Spotty Regulation, Mandatory	Comprehensive Regulation, Mandatory
16. Regulations Requiring Reuse or Safe Disposal	Few or none, Limited scope				Many, Comprehensive
17. Financial Incentives, Subsidies, or Capital	Unavailable				Available
18. Legal Liability	Unclear, unlimited				Clearly defined and limited

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The criteria for judging the merits of various sponsors derive both from the functions which clearinghouses and exchanges should perform, and from the sponsor's interest. The overriding interests of sponsors are two:

- effectiveness of the clearinghouse or exchange in facilitating transfers of scrap wastes, and,
- Financial performance.

From these goals flows a simple hierarchy of related criteria:

- Economic success depends upon the transfer agent's effective performance of services needed by client generators and users.
- Effectiveness depends upon enjoying the confidence of both types of clients.
- Confidence depends upon many factors, but at least the transfer agent's reputation and ability in maintaining each client's data confidential both from competitors and from government regulators.
- Thereafter, confidence rests upon the agent's skills and whether these suit each client's specific needs. Skill requirements are relatively few and simple for a clearinghouse, but many and complex for an exchange.

These criteria will guide in ranking the sponsorship arrangements most likely to favor effective performance. Table E-3 summarizes the factors operating for and against each type of sponsor institution.

An industry association, in general, would be the best sponsor for a clearinghouse, especially of the non-profit and subsidized or break-even type, because the association has industry acceptance and the needed clerical skills. But this conclusion does not apply to a materials exchange, because associations lack the needed technical and entrepreneurial skills. At the national level, one logical candidate to sponsor an information clearinghouse would seem to be the U.S. Chamber of Commerce, which might in time link and coordinate clearinghouse services by several regional chambers. Another would be the Manufacturing Chemists Association (MCA), which represents 185 companies having 95% of the installed chemical manufacturing capacity in the United States and Canada. But, the MCA lacks a formal structure of regional chambers; thus it would presumably have to offer a service of national scope, perhaps relying upon both informal regional networks of its own members and existing clearinghouse programs, such as that in St. Louis.

TABLE E-3

INSTITUTIONAL SPONSORSHIP: OPTIONS AND MERITS

Type of Operator or Sponsor	Information Clearinghouse	Materials Exchange
I. NON-PROFIT		
INDUSTRY ASSOCIATION (non-profit) Examples: Chambers of Commerce, St. Louis Regional Commerce and Growth Association, Greater Philadelphia's Penjerdel Corp., Manufacing Chemists Association.	**FOR:** Acceptable to industry, skills available, costs low, compatible with sponsor's mission, good for community relations, operating experience of St. Louis and European models available, start-up easy, no legal hindrances. **AGAINST:** Economic self-sufficiency not yet proven, national assoc. of large firms may not attract use by small which need service more.	**FOR:** Generally acceptable to industry. **AGAINST:** Entrepreneurial instincts, technical skills and facilities lacking, thus not credible to potential clients, broad membership unlikely to approve service for narrow group, associations not designed to manage/oversee business enterprises, non-profit status conflicts with for-profit subsidiary, start-up difficult, initial investment significant, risks too great, cannot subsidize heavily or for long.
RESEARCH INSTITUTE (non-profit) Examples: Franklin Institute, Philadelphia; Battelle, Stanford Research, Swedish Water/Air Lab in Nordic Exchange.	**FOR:** Same as above; technical specialists also available; compatible with mission. **AGAINST:** Requires contract funds to operate, not likely to subsidize from own reserves.	**FOR:** Acceptable to industry, technical skills and facilities perhaps available, non-profit status may reduce some costs (e.g., interest, taxes). **AGAINST:** Management of a business, financial risks, and likely need to subsidize not compatible with research mission; entrepreneurial skills perhaps insufficient, detailed knowledge of process industries and materials markets probably insufficient; compliance with regulations governing haulers and processors of industrial wastes.
II. INDUSTRIAL FOR-PROFIT		
INDUSTRIAL RESEARCH FIRM (for profit) Example: Arthur D. Little, TRW.	**FOR:** Some as for non-profit, institute. **AGAINST:** If a limited, subsidized demonstration, needs outside contract funds; if a business venture, needs corporate investment (if capital not better invested elsewhere) and staff interest; venture may not match business goals; overhead costs high in competition against specialized broker or listing service.	**FOR:** Acceptable; technical, managerial, and some market skills available. **AGAINST:** May not be compatible with research business, continuous staff interest not assured, opportunity costs probably high, thus internal financing difficult, overhead costs burdensome.
SECONDARY MATERIALS FIRMS (metals, paper, etc., but not chemicals; "Brokers" transfer information only, "Dealers" transfer materials).	**FOR:** Loosely related to existing business, brokers know economics and techniques of clearinghouse role, useful scanning and market research tool for dealers. **AGAINST:** Opportunity costs, reluctance to expand into unproven new services and markets.	**FOR:** Dealers have basic handling and transport facilities. **AGAINST:** Brokers and dealers both lack technical, market, and regulatory skills in chemical process industries; brokers also lack facilities; opportunity costs and start-up costs high; internal financing difficult.

TABLE E-3 (Continued)

Type of Operator or Sponsor	Information Clearinghouse	Materials Exchange
CHEMICAL BROKER Example: American Chemical Exchange, Trans Chemical.	**FOR:** Established reputation, technical and industrial knowledge, closely related to existing services and clientele, economics of clearinghouse role familiar, useful scanning and inventory tool. **AGAINST:** Opportunity costs, uncertainty of profits, not eligible for government subsidy.	**AGAINST:** No handling facilities, labs, or technical staff; not compatible with information brokerage business.
CHEMICAL RECLAMATION FIRM Examples: Rollins-Purle, Shirley-Aldred Group (U.K.), Wimborne-CPR, Western Processing, Zero Waste Systems.	**FOR:** Some as broker; even if profit low or negative, still useful adjunct to major services. **AGAINST:** Same as broker.	**FOR:** Established reputation and credibility, facilities, staff, business, and regulatory knowledge available; central to business mission; fits entrepreneurial style. **AGAINST:** Opportunity costs of diverting resources from reclaiming materials with established value.
III. GOVERNMENT		
GOVERNMENT REGULATORY AGENCY State and local environmental protection departments.	**FOR:** Cost low, skills available, useful tool to help inventory wastes, agency's mission provides incentive, start-up easy. **AGAINST:** Conflict of interest with regulatory role, thus most generators will not use voluntarily; enforced listings neither acceptable politically nor feasible administratively; thus limited, partial coverage reduces effectiveness and economic viability.	**FOR:** Minimum technical, legal, and managerial skills available; storage and transport available, some costs low (no taxes or interest), incentive from mission take needed site by eminent domain. **AGAINST:** Conflict of interest; key skills probably lacking; competing against private firms; serving only narrow sector of public; start-up difficult; geographic coverage limited to state or local boundaries; budget, accounting, and civil service procedures costly and limit essential flexibility; costs and risks make economic success highly unlikely.
GOVERNMENT SERVICE AGENCY Commerce and development departments, perhaps via government lab, e.g. U.K.'s Warren Springs Lab.	**FOR:** Same as regulatory agency, except less justified by agency missions. **AGAINST:** Competition for resources from agency's other programs, opposition from those agency constituents not benefited; generator's suspicion that data not insulated from regulatory agencies.	**FOR:** Minimum managerial skills, perhaps some facilities, some costs low, eminent domain. **AGAINST:** Even fewer technical skills the regulatory agency, less incentive, and all other barriers noted above.
GOVERNMENT CORPORATION Maryland Environmental Service (MES), New York Environmental Facilities Corp., Connecticut Resource Recovery Authority, Gulf Coast Waste Disposal Authority, Philadelphia Industrial Development Corporation, local sanitary districts, multistate authorities.	**FOR:** Same as above, if justified by mission; greater efficiency possible. **AGAINST:** Same as above. Conflict of interest actual (e.g., Maryland Environmental Service is within Dept. of Natural Resources) or suspected by industry.	**FOR:** Greater flexibility than agencies to mobilize skills and resources and start-up, eminent domain power, costs lower via greater efficiency from business management practices, perhaps required by law to serve localities (MES). **AGAINST:** Conflict of interest, demand too low or unstable to justify hiring key technical staff, risks and costs may conflict with obligation to be economically viable, greater efficiency possible but not assured, competing against private firms, geographic service area may conflict with natural economic market area, no advantage over private firms in complying with environmental regulations.

In the for-profit industrial sector, secondary materials firms, dealing in scrap materials such as metals and paper, might seem to possess some interest and business skills for venturing into transferring industrial process wastes; but such firms typically lack the special technical skills and facilities needed for success in the quite different industry based on process wastes. Chemical brokers and reclaimers, however, do have such technical and marketing knowledge, as well as reputations with potential clients of transfer services. They are therefore the most likely candidates for investing in the waste transfer business, first by testing the market by offering a clearinghouse service, then by progressing to a full materials exchange service.

Most government agencies have the facilities and skills to offer information clearinghouse services. None, however, even those lacking regulatory powers, would be acceptable to industry. Moreover, few have the technical skills, the entrepreneurial style, and the organizational mandate required to run a materials exchange. Financial sponsorship is possible, but only when confidentiality of client data is guaranteed strictly. This conclusion applies to all levels of government–federal, regional, state and local–and to all types of bodies–including line agencies, special-purpose governments and corporations, public utility commissions, and public utility companies holding franchises from government and operating under its supervision.

Regional Networks for the United States

Opportunities for transfers between services will grow. The St. Louis clearinghouse already accepts listings from outside the St. Louis area; it also received two inquiries about establishing reciprocal agreements with transfer services in other regions. Zero Waste Systems reports that it occasionally facilitates transfers between the San Francisco Bay Area and other locations, including Los Angeles and Texas. Informal networks operate within some professional societies and large corporations.

In each case, the economic gains of the transfer must be large enough to cover the greater costs of interregional transportation. Moreover, the more attractive a potential transfer is economically, the more incentive a generator and a user will have to find each other directly and, conversely, the less incentive they will have to seek help from a transfer service and pay its charges. Nonetheless, occasions will arise when a scrap waste offered and listed by one service will match a request listed by another service, and procedures for such opportunities should exist.

The next step would be for several local services to be linked with each of them via one central switchboard, such as the Manufacturing Chemists Association or U.S. Chamber of Commerce. This network of transfer services seems most efficient in that it allows local agents to concentrate on the local situation while providing the opportunity for inter-local or inter-regional transfers of selected waste offerings.

APPENDIX F

LEGAL ASPECTS OF TRANSFERRING WASTES

THE POTENTIAL FOR LEGAL LIABILITY

The liability questions surrounding waste transfer cause both concern and confusion. Concern stems from recognition that some industrial waste may be potentially toxic or hazardous, particularly if handled improperly. Confusion stems from the lack of clear legal precedents about where responsibility lies in the event of accident.

The possibilities for accident are legion. A few obvious examples include: spillage in the transfer of wastes from generator to hauler, leakage from containers used in transport; overturning of trucks; ailments, from skin rash to cancer, in persons handling waste at any stage; development of customer dissatisfaction with products, as manufacturers shift from virgin materials to scrap waste materials.

An accident is "an event occurring by chance or from unknown causes". Nonetheless, if an accident causes loss or injury, the injured party may be entitled to legal relief. Questions about who provides relief can be of paramount importance to the parties to a transfer. Answers may vary from state to state in accordance with their statutes.

Thus the danger of liability looms large in the minds of both generators and potential users of wastes. If transfer of wastes proves to be an invitation to law suits, few companies will agree to participate. Litigation is both time consuming and expensive, not to mention the probable adverse effect on corporate image.

At the outset, it should be recognized that legal considerations can be viewed as creating both positive and negative incentives relevant to the development of the waste transfer concept. The continued development and refinement of pollution standards, in conjunction with vigorous enforcement of those standards, must be seen as creating positive incentives. As private disposal becomes increasingly difficult and expensive to maintain, generators are apt to become more responsive to the possibilities inherent in transfer.

Conversely, a regulatory environment which encourages or otherwise makes private disposal simple to the point of being costless will discourage experimentation with transfer services. In this context, any potential for legal liability which may exist can be expected to be cited as one reason for noninvolvement. This liability may, in many respects, be remote. It is, however, a factor of concern especially to waste generators.

In general, this potential falls into three categories:

(1) public liability of certain kinds of waste;
(2) liability to third parties for injury resulting from waste; and
(3) contractual liability to users with regard to the contents of waste.

At the heart of each of these categories lies a common fear among various generators that they will be held legally accountable (or be accused of being responsible for) the effects of waste under circumstances over which they have relinquished control, namely while it is in transit or in the possession of either a materials exchange or a user.

Public Liability

Waste products with particularly hazardous or demonstrably toxic quantities are presently subject to a variety of statutory patterns and enforcement policies. It is difficult to generalize about the various approaches involved because of the differences in potential harm which result from different wastes. In a limited number of instances, as in the case of radioactive materials, a combination of federal statutory and administrative policy makes transfer of the waste legally impossible. In others, as in the case of explosive or highly inflammable materials, legal standards affecting transportation and handling add substantially to the cost of facilitating a transfer.

In the overwhelming majority of cases, the waste involved is neither explosive nor so obviously dangerous, hazardous, or toxic, as to have given rise to specific statutory treatment of the type described here. Any given waste, however, may be potentially injurious under some circumstances. Consequently, the enactment in recent years of pollution control statutes at the state level has given rise to fears on the part of generators of uncertain enforcement. Specifially, they are concerned that wastes which have been traditionally disposed of privately and without broader exposure may become exposed to spills and other mishaps which may ultimately result in a violation of these statutes. More specifically, many generators fear that they will be legally held responsible for the packaging, handling, and transportation of waste while under the control of a transfer agent or a user.

There is some legitimate basis for those fears. Standards in pollution law are presently in an evolutionary process. Liability can exist under a theory of negligence or one of strict accountability, i.e., without regard to the care exercised. Moreover, violations could result in criminal fines or injunctions, both of which could result in potentially large legal fees and/or adverse publicity. As long as there is uncertainty as to the standard of care which might become involved, generators are likely to be somewhat inhibited from injecting certain kinds of waste into the public stream of commerce.

Closely related to the question of public liability is the question of public exposure of information relevant to certain kinds of waste. Along with the federal government, almost all states place some kind of controls on the transportation of some potentially harmful materials (including wastes). New Jersey and Pennsylvania emphasize controls of "industrial" waste generally. Others tend to focus on "hazardous" waste. Under either approach, however, there is some need to identify the particular waste being transported.

This identification would be in public documents. Although governments have a responsibility to keep trade secrets confidential, there remains nonetheless a concern by generators that information would be available which might prove valuable to competitors anxious to learn of manufacturing processes or other internal considerations relevant to the trade secrets. Or, it might be interpreted by particular government agencies or public-oriented groups as deserving of further inquiry relevant to pollution or product content.

The concern here is for *scrutiny* over matters which are perceived to be solely private. If it were known that scrutiny of this type was harmless, generators would exhibit less concern. At this stage, however, they are, in fact, concerned about unknown ramifications, and that leads to some caution or suspicion about waste transfer possibilities.

Liability to Third Parties

A separate legal concern of generators is the potential for liability to third parties, namely, persons other than those directly involved in the transfer. The most recurring fear is liability for personal or property injury resulting from a waste in transit between generator and user.

Liability of this type is not unlike the public liability discussed above. In the former, liability generally exists in the form of administrative or criminal penalties or injunctive (i.e., cease and desist) orders. In contrast, liability to third parties is conceived in terms of compensatory damages for injuries sustained. It can lead to substantial monetary judgments, as in the case of multiple deaths. By and large, this would result from the application of "tort" law.

The general legal standard for tortious conduct, common to all the states, is one of simple negligence. In the context of transferring waste, negligent behavior could become involved in packaging, transporting and general handling during movement. The standards will differ depending on the potential for injury of any particular waste. For example, the greater the toxicity involved, the higher the standard of care which will be imposed by a judge or jury under negligence law.

Legal responsibility for negligent behavior does not extend beyond the party or parties responsible for the negligence. Thus, as a matter of strict rational principle, a waste generator would not be held accountable for the negligent behavior of scrap users or a materials exchange. As a practical matter, however, generators tend to be large and publicly-known corporations. They are often perceived as having the resources to compensate injured persons. They have, therefore, some reasonable fear that the transfer process will force them into a zone of liability exposure beyond their control.

This exposure is compounded by the threatened emergence of new standards of legal accountability in the context of the public statutes and administrative regulations. There is substantial support in the general law of tort recovery for the incorporation of new standards adopted to prevent certain kinds of harm. Thus, an emerging body of administrative law which is preventive in orientation—designed to impose strict standards on the part of waste generators without regard to the party who eventually causes harm—could conceivably be brought into play as the appropriate standards for determining and assessing compensation responsibilities.

Here again, the issue is largely one of the unknowns inherent in an emerging body of law. Waste generators are, and will be, holders of substantial insurance coverages designed to protect them against liabilities of this type. At the same time, any increase in liability will eventually result in an increase in insurance premiums. Thus the question of liability manifests itself in economic terms; given the potential for liability, generators will demand compensating benefits as a condition for participating in waste transfers.

Contractual Liability

The third legal concern is that of contractual responsibilities. In its most operable form, operations of a materials exchange will be manifested in written documents evidencing the various terms and conditions negotiated. An information clearinghouse is not likely to need such contracts; an exchange handling the materials needs this protection.

For the most part, these contracts can be expected to represent the agreements of the parties. Therefore, they will be enforceable on terms and conditions mutually defined. Thus, questions involving liability for third party inquiry can be stipulated by contract and any risks anticipated can be allocated accordingly. To the extent that generators tend to be larger and financially stronger organizations, they will have the negotiating leverage to shift the responsibility for ultimate liability to the waste users. This is not necessarily unfair. Unless some new standard of responsibility is developed (which would place liability with the exchange as a risk-spreading cost to be shared equally by all participants), users would seem to be in the best position to control the handling of the waste and take the steps necessary to prevent foreseeable mishaps.

One concern is the possible responsibility for the quality of waste. Generators as a class would prefer to participate in a transfer on an "as is" basis; that is, they would not want contractual responsibility for the specific chemical content of a generally defined waste product. Under this approach, users would be counting on the chance that a given scrap contained a specific compound of sufficient quantity and/or purity to make accepting it economically feasible.

This, however, could be viewed as an essential part of normal market mechanisms. Any fixed responsibility which could place generators in a warranty position would escalate the cost of the transfer beyond feasibility. Users can be presumed to have sufficient technical knowledge to behave as informed buyers and can be expected to negotiate price in terms of expected product performance.

Market mechanisms can also be expected to help prevent undue responsibilities being placed on the exchange itself. Because of the position occupied by the exchanges, they will be able to secure needed protection through contractual stipulation. That is, the essential quality of the role performed by the exchange affords sufficient negotiation leverage to prevent the acceptance of any responsibility for the conduct of the transaction itself.

OTHER LEGAL CONSIDERATIONS

The regulatory framework affecting alternative institutional arrangements and laws which might either inhibit or favor one over the other were examined. There are impacts on transfer organizations which result *indirectly* from governmental legal and regulatory activities; for example, the stricter the enforcement of governmental control standards, the greater the economic incentives for generators to find alternative means of disposal. In general, however, there are no particular laws or regulations which have any comparable *direct* effects.

The general law of tort and contractual liability suggests some implications for materials exchanges. As with other legal considerations, however, these implications are not unique in applying to waste transfers or materials exchanges, and must be viewed as raising cost consequences which fall into the category of imposing the normal obligations inherent in almost any economic pursuit. Moreover, these legal questions become moot when economic analysis shows that a company acting purely as a materials exchange would not be likely to survive financially.

Two other broad legal areas were examined: legislation and regulations concerned with waste management and related environmental issues; and anti-trust standards, because of their potential for affecting industry associations, the most likely sponsors of clearinghouses.

Statutes and regulations of the federal government, New Jersey, and Pennsylvania were examined. Local ordinances are generally derived from and less sophisticated than their state statutes. Nothing in this legislation can be interpreted either to favor or obstruct the development of one form of transfer organization or sponsorship over others. As noted, stricter enforcement of pollution control standards can be viewed as encouraging transfer as a more economical form of disposal by generators. Similarly, the authority of the U.S. Department of Transportation (DOT) to regulate the transportation of some materials under authority of the Hazardous Materials Transportation Act of 1975 necessarily has cost consequences which indirectly affect the economics of negotiated transfers. Since DOT's authority reaches all aspects affecting commerce, it extends to transfers within state boundaries and can be viewed as applicable even in states which lack equivalent legislation. Nonetheless, such regulation must be viewed in the same category as general economic regulation. Any cost consequences, as for example with taxes, shall be considered a normal part of the conduct of the activity concerned.

Much the same can be said for anti-trust issues. The primary administrators of the anti-trust laws—the Federal Trade Commission and the Department of Justice—have shown particular concern for the activities of trade associations and other arrangements jointly sponsored by two or more members of the same industry. The general thrust of the law is to discourage joint undertakings which might stabilize prices, inhibit new entries into field, or prevent one of the sponsors from pursuing that activity by itself. It is difficult to visualize institutional arrangements for waste transfers which would run afoul of these anti-trust constraints. Moreover, our economic analyses show that the availability of profit-making opportunities are at best limited. Furthermore, existing clearinghouses are typically subsidized and sponsored by industry associations because other institutions are not willing or acceptable. Therefore, absent an unusual situation arising from improper motives, the anti-trust laws do not appear to impose either direct or indirect restraints on the development of association-sponsored clearinghouses or commercial information services.

GLOSSARY OF NAMES AND TERMS

CEFIC. Conseil Européan des Fédérations de l'Industrie Chimique (Council of European Chemical Industry Federation), Brussels.

HWMD. Hazardous Waste Management Division, one of several operating units of the Office of Solid Waste Management Programs (OSWMP), U.S. Environmental Protection Agency.

MCA. Manufacturing Chemists Association, Washington, D.C., the major North American industry trade association, made up of 185 large companies having 95% of installed capacity in the United States and Canada.

OSWMP. Office of Solid Waste Management Programs, a major program organization of the U.S. Environmental Protection Agency (EPA). One of several units within OSWMP is the Hazardous Waste Management Division (HWMD).

Abfall. German term for waste or residue. (*Afval* in Dutch.)

Abfallbörse. German term for "waste exchange" (called waste *information clearinghouse* in this study). (*Afvalbeurs* in Dutch and Flemish; *Avfallbörs* in Swedish.)

Bourse des Déchets. French term for "waste exchange" (called waste *information clearinghouse* in this study).

Broker. An agent which negotiates transactions. In the secondary materials market, an organization which arranges transfers of secondary materials but, unlike a *dealer*, does not handle the materials physically.

By-product. A salable industrial *residue* with an established use.

Clearinghouse. See *information clearinghouse*.

Client. The term adopted by this study in order to maintain a clear distinction between "users" of a transfer service (both generators and receivers) and "users" of the transferred wastes. Not meant to imply that transfer agents must require fees from generators and receivers; in fact, most do not now charge significant fees. In the future, however, charges may be adopted in order to pay for costs now being subsidized.

Exchange. In this study, the term *transfer* is used instead of "exchange" as more accurately describing the subject of the study. "Exchange" is used to describe one type of transfer organization: the *materials exchange*. It is also sometimes part of the official name of an organization (Nordic Waste Exchange, U.K. Waste Materials Exchange).

Generator. Company or plant producing an industrial residue, and thus a potential client of a transfer agent or service.

Information Clearinghouse. A transfer agent which handles information only, typically by publishing offers of and requests for wastes and referring inquirers to the company originating the offer or request. These organizations usually operate passively; that is, they do not seek out matches for listed items or help to conduct transfer negotiations.

Materials Exchange. A transfer agent which, unlike the *information clearinghouse*, participates actively in the transfer, usually by acquiring, reprocessing, and selling the material. The materials exchanges identified in this study are profit-seeking, private-sector operations, some independent and others part of larger companies. Most U.S. transfer organizations are of this type.

Receiver. Party buying or accepting a scrap waste material for its reuse value. The receiver may also by the *user* of the waste, or may be only the middleman who treats the material to certain specifications before selling it to the ultimate user.

Residue (industrial). Material left over as a result of an industrial process. Includes both wastes and by-products; not limited to the chemical industry.

Scrap chemicals or scrap waste. The materials of primary concern to this study. They are the continually-changing class of chemical wastes which have some reuse value when the economics are right, but which have not yet become established by-products. Their non-chemical equivalent is *secondary materials.*

Secondary materials. Non-chemical recoverable items, primarily from municipal wastes. Examples are paper, bottles, cans, and textiles. Comparable to *scrap chemicals* in the chemical industry.

SMSA. Standard Metropolitan Statistical Area, one of the geographical divisions defined by the U.S. Bureau of the Census for purposes of aggregating data and making comparison on a standard basis. An SMSA's boundary, contiguous with those of counties, is drawn to include both the city and the surrounding suburban and rural areas within commuting distance.

Special-purpose government. Generic term for a governmental organization created to provide special or limited services in a specified geographical area; examples are port authorities, sanitation districts, and industrial development corporations. These public corporations (described legally as "bodies corporate and politic") usually differ from general-purpose governments in being allowed to apply principles of business administration; they differ from private corporations in having special financial powers and being chartered to provide specific services to the public.

Transfer. Generic term, replacing "exchange," for the acquisition by one plant or industry, for the purpose of reuse, of waste material generated by another plant or industry. Both a noun (a transfer) and a verb (to transfer).

Transfer agent. Any person or organization providing services intended to facilitate transfers of industrial wastes. Two types of transfer agent or service are described in this study: the *information clearinghouse* and the *materials exchange*.

Transfer organization. A transfer agent that is an organization rather than a person.

Trash waste. Waste that has no current or foreseeable reuse value and must be disposed of into the environment.

User. The ultimate consumer of the scrap waste, using it as an input to his manufacturing process. The user may receive the transferred waste either directly from its *generator* (with or without the assistance of an *information clearinghouse*) or indirectly via a *materials exchange* or scrap reclaimer.

Waste. Except where otherwise designated (e.g., household waste, municipal waste), a general term for industrial residues other than established by-products. For the chemical industry, this study divides wastes into two categories: *scrap chemicals* and *trash*.

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